Marine Engineering

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NATIONAL MARINE WEEK, which begins on October 18, and the Marine Exposition, which will be held at the Coliseum in Chicago during that week under the auspices of the National Marine League, will be primarily educational in character, a tangible proof to the people of the Middle West that the United States has developed a great shipping industry in which they have an interest and a share. As one looks back on the New York Exposition held last April, its outstanding feature is the interest which the general public took in the exhibits, despite their technical nature. The aisles were packed with men whose conception of the merchant marine was derived from Dana's "Two Years Before the Mast," and whose first-hand acquaintance with ships was confined to ferryboats and excursion steamers. You saw these same men examining the intricacies of a telemotor, bending over a reduction gear, absorbed in a map of the new steamship lanes followed by American shipping, and they left the Exposition with a truer perspective as to what the merchant marine is, and of the necessity for fostering it at the present time. The impression on the public was so pronounced as to lead many exhibitors to request that the Exposition be repeated in the Middle West, to demonstrate to the public there just what the merchant marine is, and to show them that they will benefit as immediately by its success as the people living along the Eastern and Pacific seaboards.

It is obvious that the merchant marine must secure the support of the Middle West, as the seaboard states cannot support such a great organization alone, and it is equally plain that any improvement in transportation and

> Our efforts in behalf of awakening interest in maritime affairs in the Middle West through the medium of the Chicago Marine Show and the Marine Week are meeting with most encouraging success. This affair promises to be the biggest thing of its kind ever held in the country, and with the support that now seems assured there will be no limit to the beneficial results that will follow our joint efforts to arouse enthusiasm in the American merchant marine. The people of America, by the evidence at hand, are more ship-minded than they ever were in the history of the country.—*P. H. W. Ross, president, The National Marine League.*

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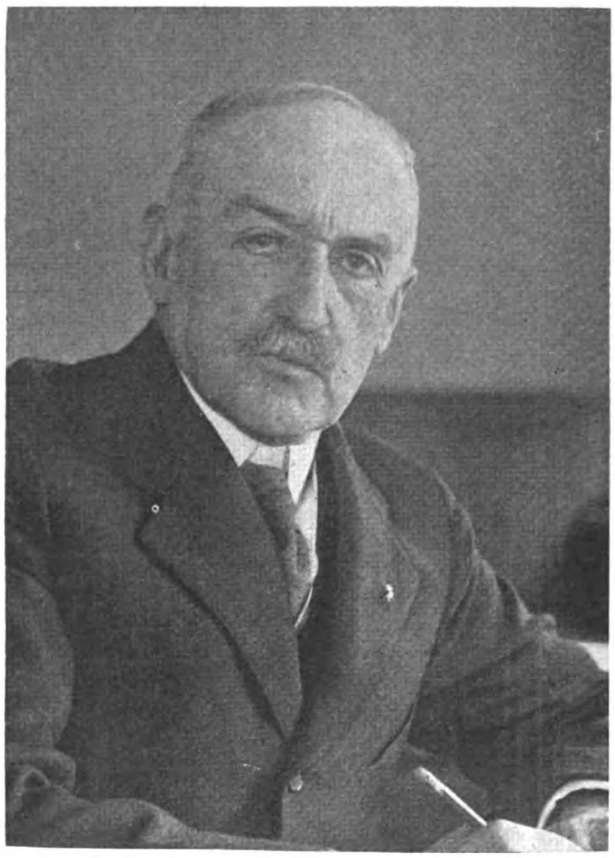
P. H. W. Ross, President, The National Marine League



Rear Admiral W. S. Benson, Chairman of the Shipping Board

the marketing of goods benefits Indiana as directly as New York. Only, the Middle West has always looked solely to the railroads and needs to be shown that shipping can supplement railroad service, if given an opportunity. A marine show is the most direct and personal method of demonstrating this. It is particularly effective at this time owing to the growth of Great Lakes shipping and the increasing interest in the Middle West over the proposition to link the Great Lakes directly with the ocean, which would virtually make Chicago, Buffalo, Cleveland and other Lake cities seaports.

In a recent pronouncement, Herbert Hoover said:

"We need a national study and a national programme of transportation development, co-ordinating both rail and water, and such a programme will not only embrace the improvement of our interior waterways but will unquestionably call for the improvement of the St. Lawrence route.

"That the ports on the Great Lakes can be put effectively on seaboard with a comparatively moderate expenditure is unquestioned, and that such an accomplishment will enormously improve the prosperity of fifteen states, decrease the cost of distribution of commodities, increase the returns to the producer, require no proof."

National Marine Week, which has been arranged to take place in Chicago on October 18 to 23 inclusive, is giving a new impetus to the deep waterways movement in the Middle West. In deciding on Chicago as the Exposition city, the National Marine League has recognized its growing importance as a shipping port. With the future development of the Mississippi River and its tributaries, officials of the League predict a new commercial era for Chicago, her sister lake cities, and the Middle West in general. The attention of the people in these sections will be focused on the increasing importance of America's merchant sea power in relation to the maintenance of inland prosperity. Also the public of the entire nation will be awakened to the wealth and magnitude of lake and inland water shipping, to the end that this part of the nation's transportation problem may receive the serious attention of the various state legislatures and of Congress.

The Exposition at Chicago will be a "national study" of the programme of water transportation. It has been enthusiastically endorsed by Admiral W. S. Benson, chairman of the United States Shipping Board, who says in a recent letter to P. H. W. Ross, president of the National Marine League:

"Your letter stating that the Marine Exposition known as the Chicago Marine Show is meeting with most encouraging success reached me today. Marine Week to be inaugurated during the week of this Exposition—October 18 to October 23—will have a splendid effect in my judgment.

"Americans are now awake to the need of loyal support for our merchant marine. We have the ships—we have the opportunity to promote the peace of the world by the development of our commerce, making proper use of these ships in doing so. It is the desire of the Shipping Board to cooperate with all organizations which aim to build up the efficiency and services of our merchant marine.

"It is a pleasure to know that in the work your organization did for the Marine Exposition in New York City the people of the Metropolis were awakened to the opportunity now offered as a result of the merchant marine we now have. Surely the men and women of the Middle West and the Mississippi Valley are as vitally interested in the proper development of this merchant marine as seaboard cities and states.

"I am indeed gratified to learn that the Chicago Marine Show to be held in October is fast approaching a stage which

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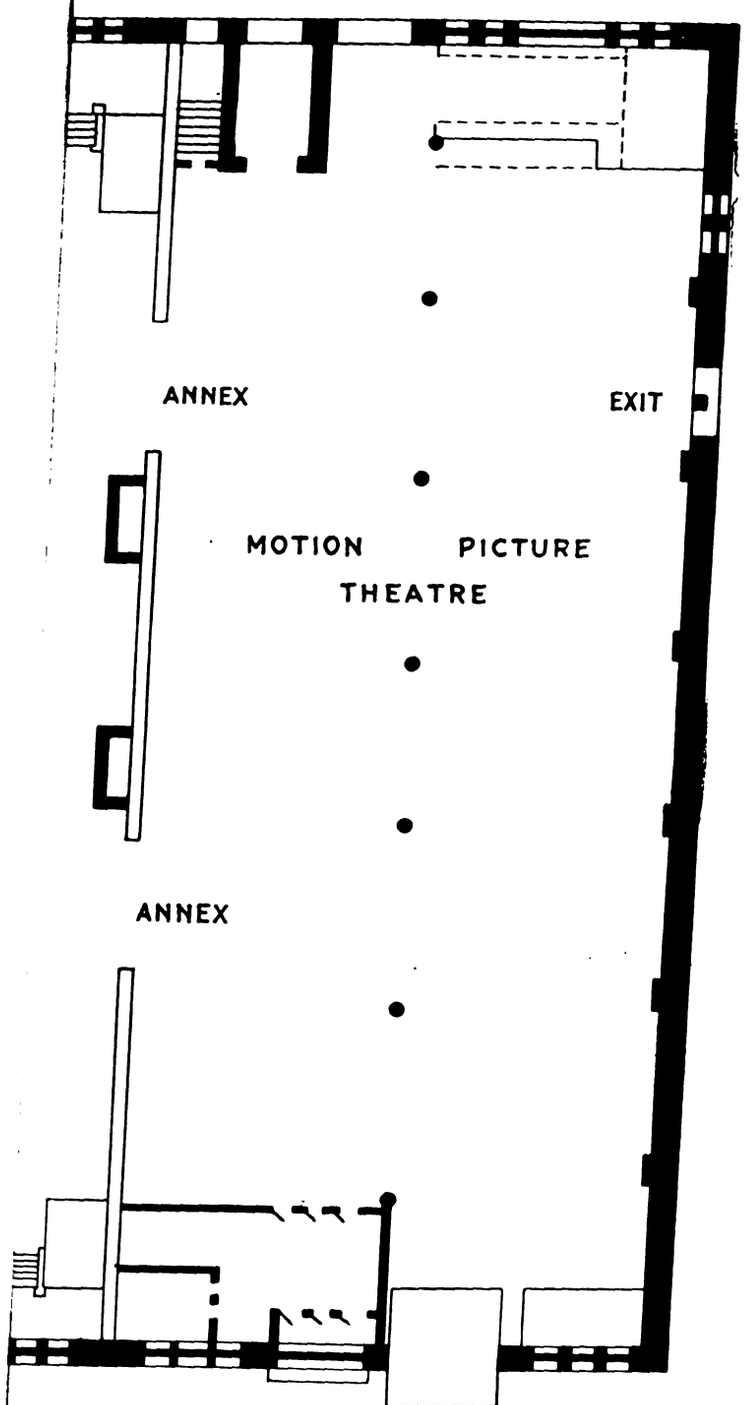

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promises, together with Marine Week, 'to be the biggest thing of its kind ever held in the country.' I agree with you that there will be no limit to the results that will follow our joint efforts to arouse enthusiastic interest in the American merchant marine.

"The Shipping Board is now at work on its exhibit for Chicago. It is our aim to co-operate with you in every way possible to make the Chicago Marine Exposition a striking success."

Admiral Benson will formally open the Chicago show and is expected to preside at the banquet to be given by the League at the Congress Hotel on October 19 as the culmination of the proceedings of Marine Week, which will last during the period of the Exposition and consists of lectures, displays and moving pictures, and meetings of prominent Chicago business men with those interested in shipping and port development.

It is natural in view of the predominantly educational character of the Chicago show that the steamship lines should be well represented. In addition to the Shipping Board, which will display the largest map ever constructed, the International Mercantile Marine, the Luckenback Steamship Company, the Munson Line, the Pacific Mail Steamship Company, and the Oriental Navigation Company will install displays.

Among the exhibitors at the Marine Exposition will be the following:

United States Shipping Board.
International Mercantile Marine.
American Car & Foundry Company.
W. & J. Tiebout Company.
Simmons-Boardman Company.
Irving Iron Works.
Pneumercator Company.
Wailes, Dove, Hermiston Company.
New York Engineering Company.
American Bureau of Shipping.
Luckenback Steamship Company.
New Process Chemical Company.
American Library Association.
New York Marine News.
Consolidated Shipbuilding Company.
The Crane Company.
The McNab Company.
Hanlon-Gregory Galvanizing Company.
Kroeschell Bros. Ice Machine Company.
Aluminum Cooking Utensil Company.
Albert Kingsbury, Engineer.
Munson Steamship Company.
American Steel Foundries.
Maritime Hydraulic Oil Service.
Lunkenheimer Company.
D. T. Williams Company.
Valentine & Company.
Geo. B. Carpenter Company.
Fairbanks, Morse & Company.
The Submarine Boat Corporation.
The United States Rubber Company.
The General Electric Company.
Chas. A. Durkee Company.
American Chain Company.
Pacific Mail Steamship Company.
All America Cables Company, Inc.
Ferguson Lange Foundry Company.
United States Public Health Service.
Pyle-Watt National Company.
White Fuel Oil Engineering Company.
The Texas Company.
Benjamin Electric Company.
Oriental Navigation Company.
Penton Publishing Company.
John A. Roebling Company.
Hubbard H. Erickson Company.

Norwegian Vessel Built in England

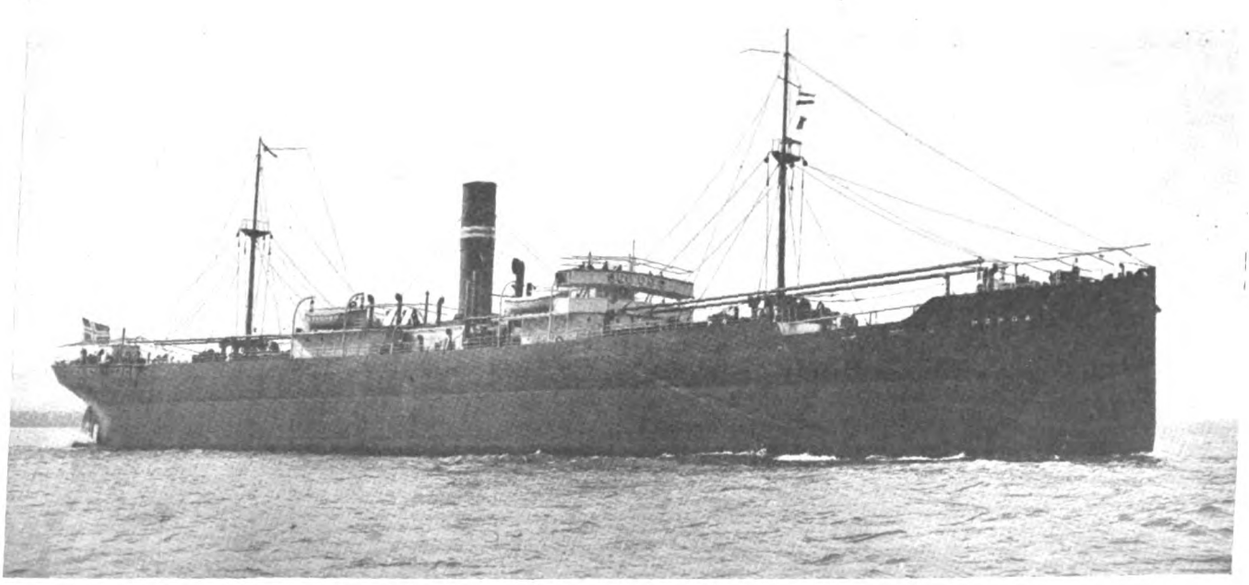
ONE of the vessels recently accepted by foreign owners from British yards is the cargo vessel *Horda* built by Messrs. William Gray & Company (1918), Ltd., West Hartlepool, for J. Ludwig Mowinckel, of Bergen, Norway.

The principal dimensions of the vessel are:

Length overall	391 feet 9 inches
Beam, molded	53 feet 6 inches
Depth, molded	26 feet 3 inches
Deadweight cargo carrying capacity	7,500 tons

The propelling machinery, fabricated at the Central Marine Engine Works of the builders, consists of a triple expansion engine having cylinder diameters of 25 inches, 41 inches and 68 inches, and a stroke of 48 inches. Steam is supplied at 180 pounds per square inch by three Scotch boilers 16 feet in diameter and 11 feet long. The boilers are equipped to burn fuel oil.

The auxiliaries include two independent feed pumps, a centrifugal pump, a general service pump, an auxiliary feed pump, a ballast pump, a condenser with combined air and circulating pumps, an oil trimming pump and an evaporator.



Cargo Steamship *Horda*, of 7,500 Tons Deadweight Carrying Capacity

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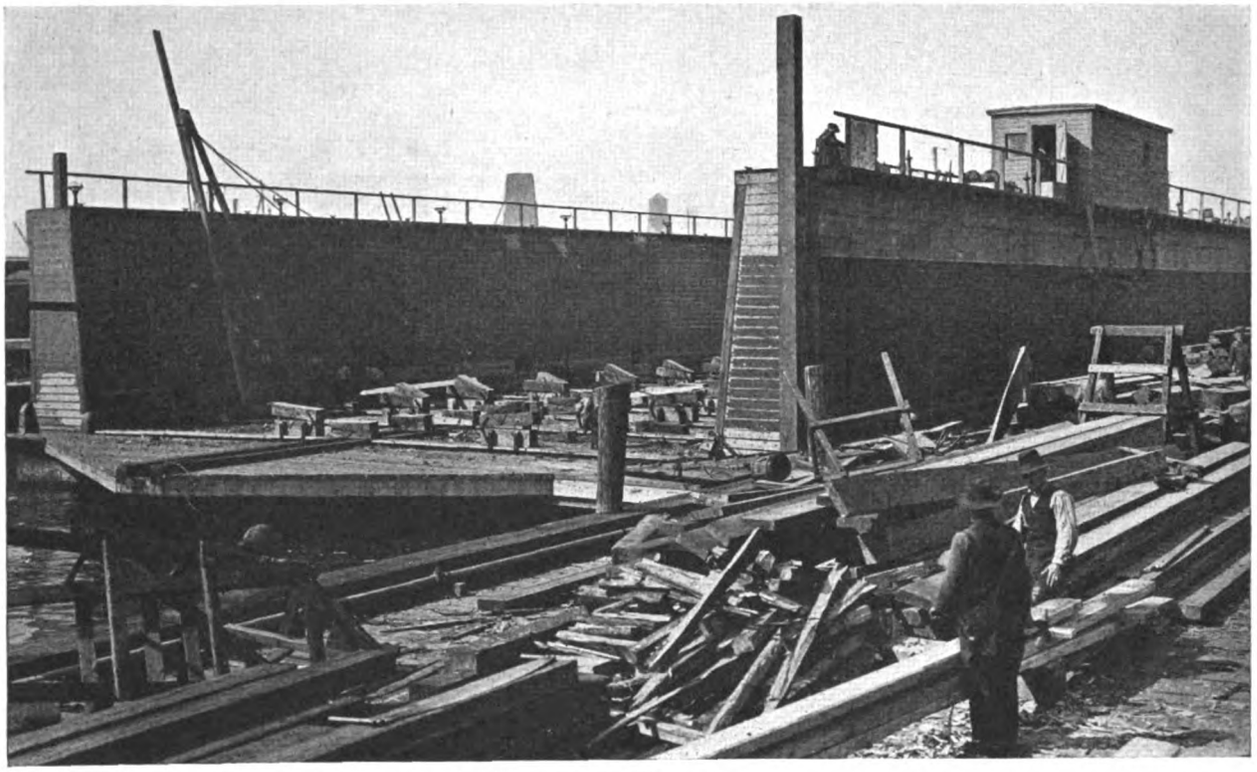

Fig. 1.—2,400-Ton Dock of Vulcan Iron Works, Under Construction

Motors for Operating Floating Dry Docks

BY WILLIAM H. EASTON*

As in all other branches of ocean shipping, America has heretofore lagged behind Europe in the construction of dry docks. From the time of the Civil War until the end of the last century, not a single commercial dry dock of importance was built in the United States, and though a number have been put into service during the past twenty years, the war caught us with utterly inadequate docking facilities. As an inevitable result of our recent shipbuilding activities, which have left us in possession of a vast fleet of merchant vessels, numerous dry docks are now either under construction or projected in many of our more important ports. It is important, therefore, that the motive power for the operation of these docks be given careful consideration.

THE new docks now being built in American harbors will be mainly, if not exclusively, of the floating type. The graving dock has, generally speaking, the advantage of a somewhat more rigid floor, but its first cost is greater, it requires more time to construct, it is more expensive to operate, is less flexible in service, and, since it must lie below water level, working conditions in it are not altogether satisfactory. Hence the floating dock, especially after the completion of the 20,000-ton floating dock *Dewey*, and its spectacular voyage to the Philippines, has generally taken the place of the older form.

Alternating Current Motors Preferred

Though the design of a successful floating dry dock presents an engineering problem of the highest order, its equipment of machinery is very simple, consisting only of pumps and valves and the means for operating them. In the older docks the pumps were driven by steam engines, but today electric motors are invariably used, unless it is impossible to obtain electric current. The valves are always hand operated.

A motor for a dry dock pump must be very strong mechanically and be thoroughly insulated and protected against dampness. The earlier motors were mainly of the single speed type, but the present tendency is to employ variable speed motors so that the dock master can control the rate of the rise of the dock by varying the speed of the pumps as well as by manipulating the valves. The alternating current, variable speed, wound rotor motor is ideal for the service and is generally used, though the squirrel cage motor is suitable where speed variation is not desired. Direct current motors can be employed, if nothing but direct current is available, but alternating current is always to be preferred because of the greater simplicity of the alternating current motor and the economy with which this form of current can be transmitted long distances.

There are several different methods of driving the pumps by means of motors, and these are well illustrated by certain docks in New York Harbor.

Vulcan Dock

The simplest type of drive is that used on a new 2,400-ton section of a dock of the Vulcan Iron Works at Jersey City, N. J. This dock is 140 feet long, has a beam of 80 feet, and wings 30 feet high. There are 24 plunger type

* Westinghouse Electric & Manufacturing Company.

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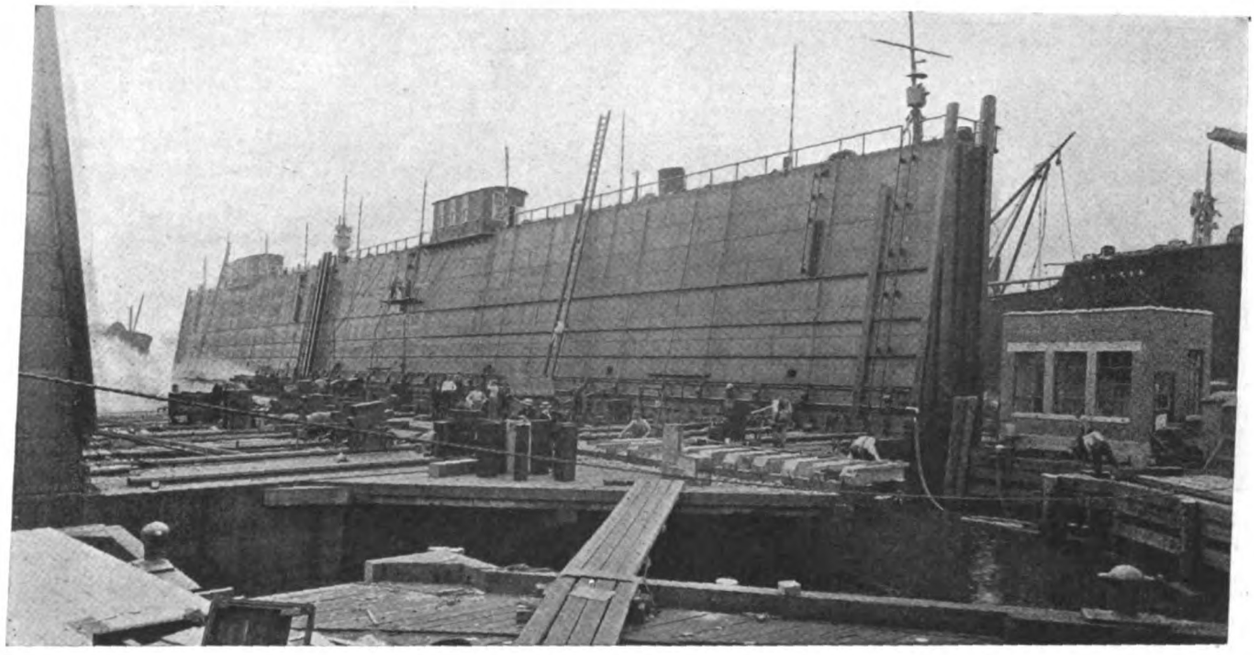

Fig. 2.—10,000-Ton Dock of W. & A. Fletcher Company. Control House at the Right

pumps, each with a cross-section of 12 by 12 inches and a 22-inch stroke, all of which are placed in one wing, and are driven by a line shaft that runs along the deck of the wing. A 125-horsepower Westinghouse motor, located in a house on the deck, is geared to the line shaft and drives all of the pumps.

This motor is of the alternating current, wound rotor type and operates on a 220-volt circuit. It is controlled by a manually operated drum type controller, also located in the house, and its speed can be varied over a range of from 250 to 500 revolutions per minute, which gives line shaft speeds of from 55 to 110 revolutions per minute. The gears are of bronze and all of the mechanical work is of the most rugged character. The motor mounting is made especially rigid by enclosing the gear end bearing housing of the motor in a box that is firmly bolted to the foundation. An oil pipe, to supply oil to the motor bearing, passes through the box.

This form of drive and control, which closely follows earlier steam drive practice, is probably the most economical and satisfactory for small docks.

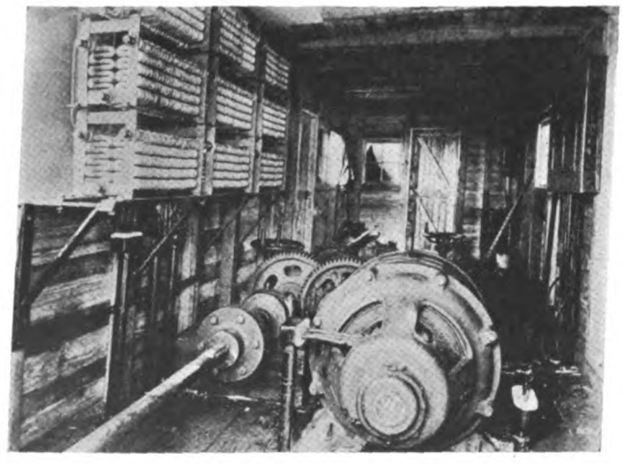

Fig. 3.—125-Horsepower Westinghouse Motor Driving 24 Pumps on Vulcan Dock. Controller in Right-Hand Corner

A somewhat similar drive, but a very different method of control, is found on the new 10,000-ton steel dock of the W. & A. Fletcher Company at Hoboken, N. J. This dock, which is 435 feet long and has a beam of 110 feet and wings 35 feet high, is built in two sections, one of which consists of 4 pontoons and the other of 5.

The Fletcher Dock

It has eighteen 12-inch centrifugal pumps, with a rated capacity of 2,200 gallons per minute each and a maximum speed of 500 revolutions per minute, which are mounted in all four wings and are driven by line shafts, as in the Vulcan dock, five pumps being driven by a 200-horsepower motor on each of the larger wings, and four pumps by a 125-horsepower motor on each of the smaller wings. The motors are of the Westinghouse variable speed, wound rotor type and are located in houses near the centers of the wings. The shaft of each motor is doubly extended, and each end is geared to a section of the line shafting.

The most unusual feature of these motors is that they operate on a 2,400-volt circuit and are probably the first high voltage motors to be used on a dry dock. Ordinarily high voltage current as received from a central station is reduced to 220 or 440 volts for use around the dock, but in the case of the Fletcher dock the high voltage lines are led directly to the motors, and thus the expense of large step-down transformers is eliminated. Naturally the greatest care has been exercised to insure the thorough insulation of the high voltage cables (which are run along the back of the wings out of the reach of the ordinary workmen), and everyone is excluded from the motor houses when the current is on.

Control System

The control for these motors is centered in a small brick house located on the pier at the end of the dock. A panel in this house carries four small drum type master controllers, one for each motor. A single operator can start, stop, speed up and slow down any or all of the motors as the dock master directs. The master controllers do not directly control the motors but control the operation of magnet switches which are mounted on panels beside each

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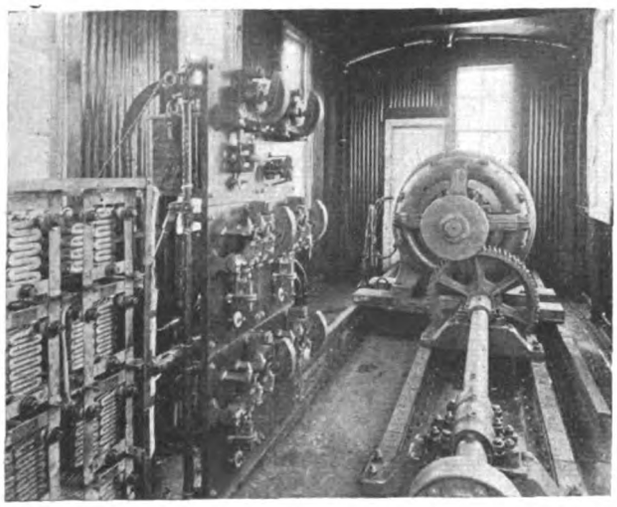

Fig. 4.—200-Horsepower 2,400-Volt Westinghouse Motor Driving Pumps on Fletcher Dock. Magnet Switch Controller at the Left

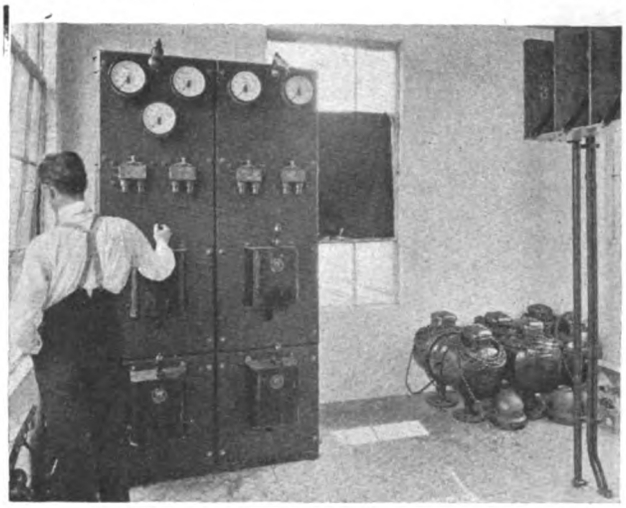

Fig. 5.—Master Controllers of the Fletcher Dock Motors

motor. Movement of the handle of a master controller causes certain of the switches on the proper control panel to close or open and thus make the desired motor connections. The master controllers do not, therefore, handle the large, high voltage currents used by the motors, but only small low voltage auxiliary currents, so that the wiring is inexpensive and the controllers are perfectly safe to handle. The master controller panel also carries an ammeter for each motor, which gives the operator exact information as to the motor's performance. In the control house are also located the high voltage cut-out switches, by means of which any desired circuit on the dock can be rendered dead.

ROBINS DOCK

A very different type of drive is in use on the large 24,000-ton dock of the Robins Dry Dock & Repair Company, Brooklyn, N. Y., which was built in 1913. This dock consists of six sections, each 80 feet long and 130 feet wide, and each section has two 20-inch vertical shaft centrifugal pumps (one in each wing) driven by a 100-horsepower, 440-volt vertical motor directly connected to the pump shaft. The motors are of the alternating current Westinghouse squirrel cage type and operate at a constant

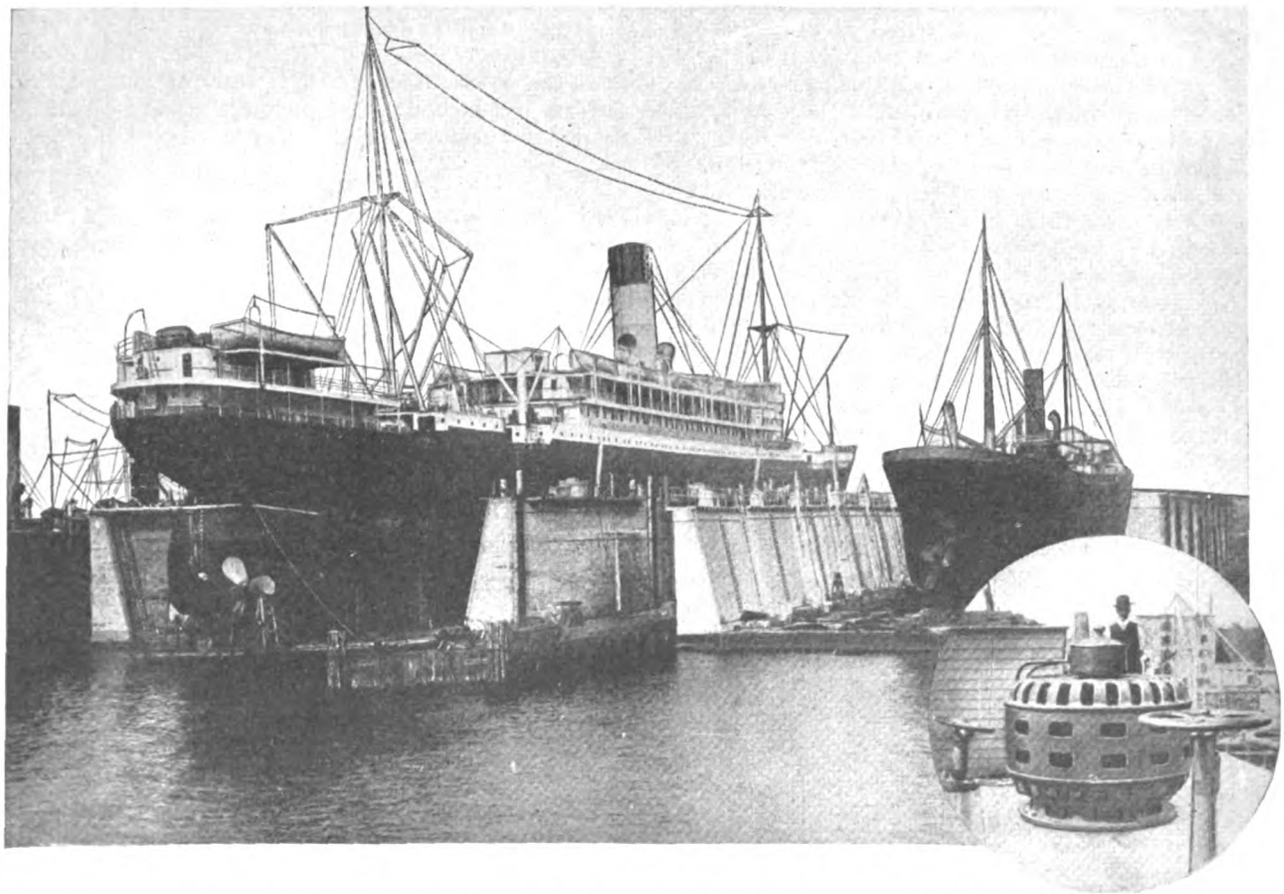

Fig. 6.—24,000-Ton Dock of the Robins Dry Dock & Repair Company. Insert Shows One of the Twelve 100-Horsepower Westinghouse Pump Motors

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speed of 290 revolutions per minute. They are controlled from a switch house on land, where they are first connected to a source of low voltage for starting and then directly to the 440-volt line for running.

For large docks this use of a separate motor for each pump is to be recommended, from an electrical standpoint, because it eliminates the complication of line shafts and gears and provides a more flexible arrangement. But it is probable that were this dock built today, the motors would be of the variable speed type; they would be controlled by master controllers and automatic switches, and it is quite likely that they would be operated directly from the high-voltage lines of the central station supplying the current.

ELECTRICALLY OPERATED VALVES A POSSIBILITY

As far as the writer is aware, no dock is using electricity to operate the valves as well as the pumps. That this is possible is shown by the fact that several water supply companies operate distant valves by means of motors and open and close them by merely pressing buttons. If a similar arrangement were used on a dry dock, the control of all of the machinery could be centered at one point.

The Status of Ship Data

BY C. H. PEABODY, DR. ENG.

In the design of a ship, existing data that have been used in previous constructions of a similar character are depended on largely for determining the qualities which will be embodied in the ship. The information available on such questions as the metacentric height of vessels, as well as skin friction and residual resistance is very meager. In fact, the determination of the latter, as well as the power necessary for a given vessel, is left to the theory of mechanical similitude with a resulting accuracy open to question. These matters are discussed in the following article and certain suggestions made for improving the present methods used in displacement, stability, power and strength calculations.

IT may be interesting to review the present status of the data available for computation of the properties of steamships. There are four classes of problems that arise concerning displacement, stability, power and strength.

The displacement may be computed from the lines with accuracy and certainty; the complementary problem of determining the weight of the ship is more difficult and uncertain, especially as there is little published information of ships' weights, but all shipyards have their weight computations and comparisons with displacement and the practical naval architect has no serious difficulty unless he is confronted with some very unusual new problem. It is difficult to assign the precision practicable in this problem, but two or three percent should cover the margin between expectation and realization.

THE SHIP'S DRAFT

The most important matter in connection with this problem is the draft of the ship, which determines the harbor that the ship can conveniently enter. Now the displacement is roughly proportional to the draft, so that a ship drawing 20 feet may have an overdraft of about half a foot on account of the two or three percent displacement just suggested as the margin of error. Such an overdraft is more an annoyance than a defect unless the assigned draft for the design is the limit available, or unless load line regulations are drastic. To be sure, an overloaded ship is harder to propel, but the loss of speed on account of two or three percent overload is probably only half of the percentage of such overload and is difficult to determine under the best trial conditions. The problems of weight and displacement may therefore be satisfactorily dealt with.

DIFFICULTY OF LOCATING CENTER OF GRAVITY

The location of the metacenter can also be determined with accuracy and certainty from the lines, but the location of the center of gravity of the ship is the uncertain feature of this problem. Improvised inclining experiments are likely to be troublesome and uncertain, but if a shipyard will take the trouble to make proper provision, there is no reason why it should cause either undue trouble or delay to incline a ship when it is undocked.

METACENTRIC HEIGHT

There is so little information published or unpublished concerned the real metacentric heights of ships that no margin can be assigned to this quantity. The real problem of stability of a steamship is the estimation of the probable time of rolling, so that the designer may be reasonably certain that the ship will be easy in a seaway. Now the square root of the metacentric height enters into the computation of the time of rolling. A desirable time of rolling of a seagoing ship is something like ten seconds, and it is unlikely that the navigator will be able to distinguish the effect of a second more or less in the time of rolling of a given ship even when the effective time of the waves approaches that of the rolling. Consequently, we may say that there is an allowable margin of 20 percent on the metacentric height of a ship in seagoing condition. Truly, the naval architect should see to it that there is a reasonable provision of metacentric height in all normal conditions of loading and unloading, so that there will be no danger of the ship capsizing at her berth, but that is another matter.

POWER FOR A GIVEN SPEED

The most exigent problem of the naval architect is the determination of the power required for a given speed, as any serious failure in this regard is immediately evident. There is an enormous amount of data concerning this problem, including, of course, the allied problem of the propeller. The data may be separated into two classes, that from experiments in towing tanks and that from power and speed trials of ships.

There are in all about eighteen model towing tanks, and of them half a dozen have published results of tests on ships' models or series of such tests, two of them have published extensive series of tests on model propellers, at least three have published information concerning the interrelations of the ship and its propeller. There have

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also been published results of the trials of sizable self-propelled models. This source of information has not been completely digested and prepared for the use of the designer, but there are two monumental works that enable the naval architect to use the general results with reasonable convenience, by Admiral D. W. Taylor and by G. S. Baker.

From Admiral Taylor's books the resistance of a model of a ship may be determined with certainty and precision provided that the ship comes within his limits and provided its speed does not come near a critical condition. The last proviso may ordinarily be met, as naval architects usually avoid critical speeds; the first, unfortunately, may be an obstacle, as the models tested were of naval types, which do not run to large block coefficients. And, again, Admiral Taylor's work on model propellers gives certain and nearly complete information for all kinds and conditions of model propellers. The only real deficiencies are concerning propellers for towboats and propellers liable to run into cavitation; the last statement is almost an hibernicism, as model propellers do not cavitate.

Continuing with cavitation, to dispose of it so far as we are now concerned, it may be said that all the information we have is Barnaby's 11¼ pounds at which the *Daring* cavitated and Speakman's recommendation that the propeller tips be limited to a speed of about 14,000 feet per minute. Everybody who approaches cavitation shys away from it and says no more about it.

The matter of the interrelation of the ship and its propeller is far from a satisfactory condition, though much work has been done by the Froudes, by W. J. Luke and by Naval Constructor McEntee. Attention may be called to the fact that the wake factor and the thrust deduction, as published, apply to models, and all we know about the corresponding quantities for ships is that they are smaller, but we don't know how much smaller.

Value of Power and Speed Trial Reports

There are numerous reports of power and speed trials of ships of all sorts and by various people, and a few reports of economy trials. This mass of material should be collected and criticised drastically by a master in order that the good may be selected and arranged for convenient use. Also there should be propaganda in favor of ship's trials under proper conditions. The writer has had enough experience to understand the difficulties of arranging trials of ships and the conditions requisite for valuable results. From this experience, and from the experience of those versed in the results of trials of naval vessels, the writer has become skeptical of the scientific value of the great mass of ships' trials and of all systems of powering ships and computing propellers that are based on the undigested mass of this information.

In the application of the results of tests of models either in comparison with trials of ships or in the design of ships, Froude's method is always used. First the surface friction is computed and subtracted and the residual resistance is isolated. So far so good; Froude's original determination of surface friction of models was unquestionably correct and has been verified over and over again by many observers. In fact, the first job for a new model tank is to measure surface friction, and if results are satisfactory the observer knows that his apparatus is working right.

Residual Resistance Computed by Means of Theory of Mechanical Similitude

The next step is to treat the residual resistance of the model by the theory of mechanical similitude in order to compute the residual resistance of the ship; thereto is added the surface friction resistance by the use of Froude's factors and exponents, which were determined half a century ago and never repeated. There is a common, though erroneous, idea that Tideman made such determinations, but in his work printed in Dutch he specifically says he did not make any tests on surface friction.

The most crying need of the profession at this moment is a competent determination of the surface friction of ships so that Froude's method may be checked. Such an investigation will be neither easy nor cheap.

Now for the application of the theory of mechanical similitude to the residual resistance; its application must be based on the fact that it conforms with the theory of the trochoidal wave, and the assumption that waves accompanying ships are trochoidal. Though it is quite certain that ships' waves are not trochoidal, the assumption is sufficiently justified by the general theory of waves and by observation on trains of waves accompanying ships and their models. Moreover, the residual resistance is usually less than a quarter of the total resistance and approaches a half only for extreme cases, where new designs are largely experimental.

So far as can be judged from tests of various sizes of propeller models, the theory of mechanical similitude applies fairly well, but the gap from a 16-inch model to a 10- or 20-foot propeller is wide. The need for experimental work to close the gap is evident, also the difficulty and extravagance of the work.

Mechanical Efficiency of Reciprocating Engines

There remains the question of mechanical efficiency of the reciprocating engine, usually estimated more or less optimistically. Truly, tests have been made by the aid of torsion meters which encourage optimism.

The experience of experts who have compared tests of models and their propellers with trials of the ships is that there is a margin of discrepancy of about 2 percent in power. That is to say, the indicated power is liable to be 10 percent less than the power estimated from the model. This makes us think that Froude's friction data are too high, which should be expected. This discrepancy, when it exists, is rather comforting, as it eases up on the designer. If we wish to be precise, we may just estimate a 2 percent discrepancy and let it go at that. Should the real discrepancy prove to be 8 percent on the one hand or 12 percent on the other, we will be only 2 percent out.

Accuracy of the Admiralty Coefficient

There remain the independent estimate of power and the Admiralty coefficient. The independent estimator uses Froude's method, going from ship to ship instead of from model to ship. Some designers use it with great satisfaction for certain classes of ships. As for the Admiralty coefficient, the oldest and by many thought to be the most reliable method, it is fundamentally an application of the theory of similitude. Some designers prefer the direct application of the theory from ship to ship, a method that has some advantages, but the Admiralty coefficient properly derived from similar ships at corresponding speeds is an old reliable method. If we had information enough under all conditions, we should need nothing better. Its worst feature is its conservatism, discouraging adventures into new fields.

Finally there is no reason why the designer should not be confident when called upon to power any ship that is not a freak. The law of power and speed favors him, namely, the law that the power varies as the cube of the speed, for conversely the speed varies as the cube root of the power.

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An error of 9 percent on the power may cause a variation of 3 percent on the speed, which is where any discrepancy shows up.

STRENGTH OF SHIPS

All problems of strength of ships are relative, because the action of the sea cannot be predicted. There is, of course, the customary calculation for longitudinal strength, treating the ship as a beam supported on a wave of the same length and loaded with the weight of the ship's structure, the machinery and the cargo. Then results a stress computed for the material of the strength deck; if the stress so computed is unusual, and especially if it is unusually small, the designer takes notice and in the latter case goes about strengthening the deck. Such computations as have been suggested for transverse strength are difficult and uncertain. The chief reliance of the designer must be precedent and progress, which must be made slowly step by step. There have been a few instances of ships breaking in a seaway—for example, the destroyer *Viper*—but the chance of failure of conservatively designed merchantmen is very remote. Since registration societies specify the scantlings for all classes of ships, the designer has little scope for originality, except as he proposes some equivalent construction for that specified.

Fruit Steamers Hibueras and Nicarao

Combined Fruit and Passenger Vessels Built by the Standard Shipbuilding Corporation for Service in the Honduran Fruit Trade

BY CHARLES FELDMAN

THE Standard Shipbuilding Corporation, Shooters Island, N. Y., has completed its first private contract since the war construction period. The vessel is the steamship *Hibueras,* one of the two special type combination fruit and passenger steamers recently constructed for, and delivered to, the Cuyamel Fruit Company, New Orleans, La. The *Hibueras* and her sister ship, the *Nicarao,* which were built under the supervision of William Gardner & Company, New York, were transferred without change of ownership to Honduran registry while under construction, their hailing port being Puerto Cortez.

These ships are reported to be the first combination fruit and passenger steamers constructed in the United States for foreign registry.

The vessels were built and classed to the rules of Lloyd's Register of Shipping, *100 A-1, shelter deck, and in accordance with the rules and regulations of the United States Steamboat Inspection Service.

PRINCIPAL DIMENSIONS

The principal dimensions of these steamers are as follows:

Length between perpendiculars	235 feet 0 inches
Length overall	248 feet 0 inches
Beam, molded	34 feet 0 inches
Depth to upper deck	16 feet 0 inches
Depth to shelter deck	23 feet 6 inches
Sea speed at load draft of 15 feet 8 inches	11 knots

GENERAL ARRANGEMENT

From the general arrangement plans (Figs. 3 and 4) it

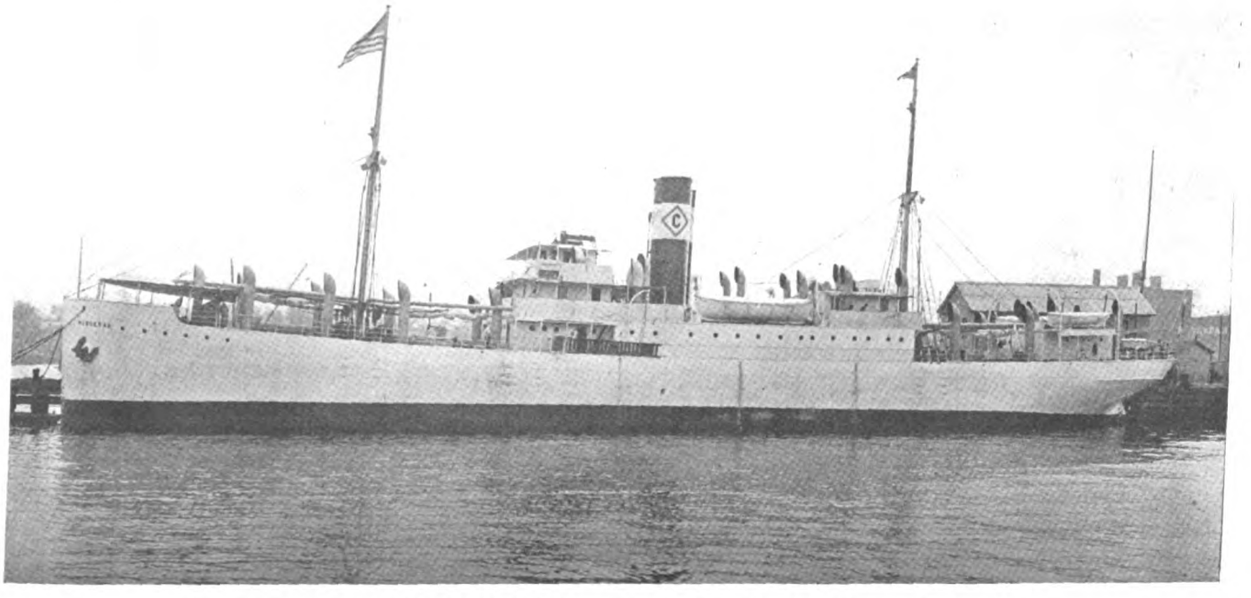

Fig. 1.—Passenger and Fruit Steamer *Hibueras,* Designed by William Gardner, of New York

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will be seen that the steamer is of the shelter deck type, with two permanent continuous decks for the full length of the ship and a portable sparred wood orlop deck, with steel beams, forward and aft of the machinery space. On the shelter and boat decks steel and wood superstructures are built for the housing of the crew and passengers.

A cellular double bottom extending the full length of the ship between the peak bulkheads is used for stowing fuel oil, excepting the part under the engine, in which feed water is carried.

SCANTLINGS

Forgings—

Stem, 7 inches by 2⅛ inches.
Rudder post, 6¼ inches by 5 inches.
Propeller post, 7 inches by 5 inches.

Frames—

Spacing, 22½ inches.
Bulb angles, 6 inches by 3 inches by .35 inch.
Frames in peaks, 5 inches by 3 inches by .38 inch.

Beams—

Shelter deck, every frame, angles, 5 inches by 3 inches by .312 inch.
Second deck, every frame, angles, 5 inches by 3 inches by .34 inch.
Pillars in engine room to be arranged where practicable.

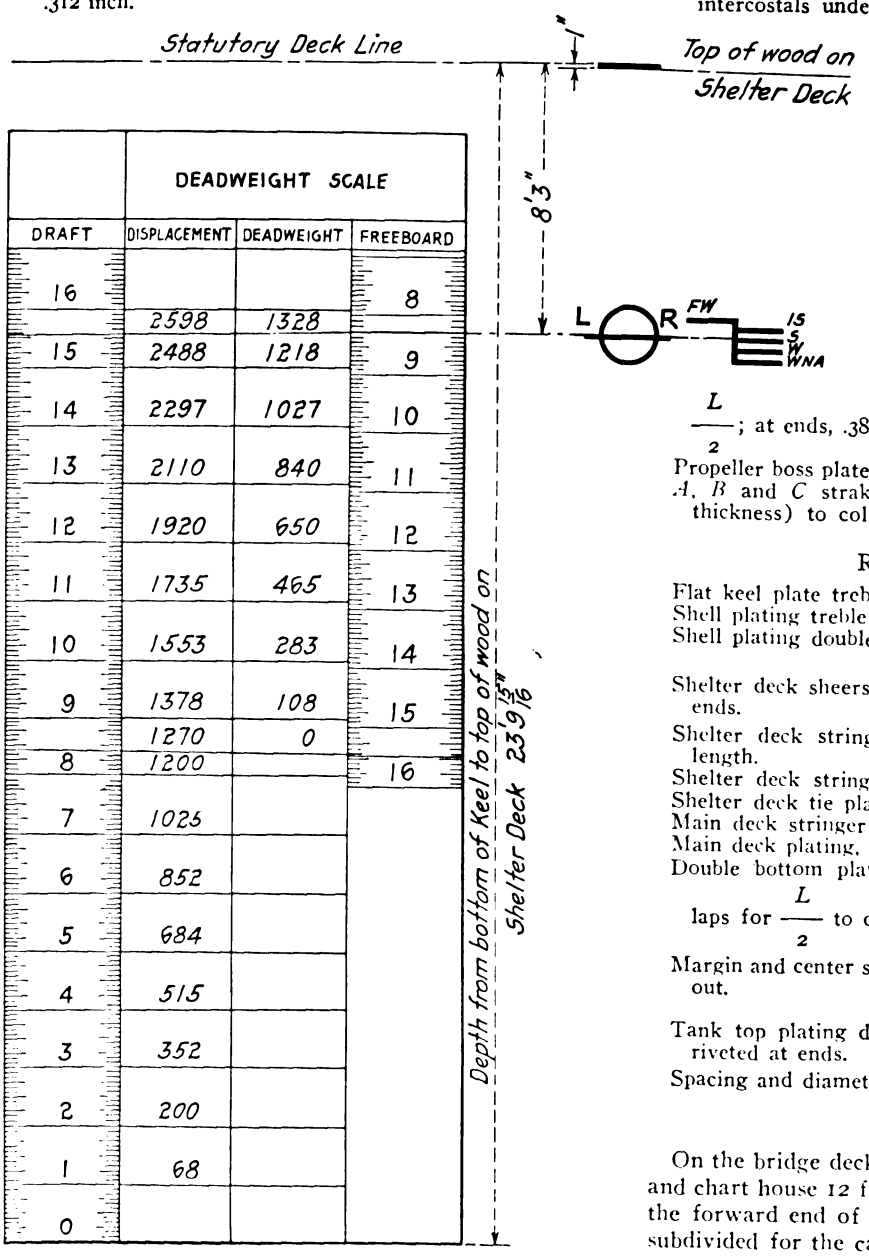
DOUBLE BOTTOM

Plating—

Center strake, 33 inches by .38 inch for $\frac{L}{2}$; ends, .32 inch.
Center strake, .46 inch in boiler space.
Other strakes, .30 inch $\frac{L}{2}$; ends, .28 inch.
Other strakes, .46 inch in boiler space.
Other strakes, .34 inch in engine space.

Floors and Brackets—

.30 inch for $\frac{L}{2}$; ends, .30 inch.
Floors .40 inch in boiler space.
Floors in peaks .32 inch.
Floors to be fitted at every frame in engine space and under boiler bearers and from the 3/5 length forward to collision bulkhead. No holes to be made in floors and intercostals under pillars.



DRAFT	DEADWEIGHT SCALE DISPLACEMENT	DEADWEIGHT	FREEBOARD
16			8
	2598	1328	
15	2488	1218	9
14	2297	1027	10
13	2110	840	11
12	1920	650	12
11	1735	465	13
10	1553	283	14
9	1378	108	15
	1270	0	
8	1200		16
7	1026		
6	852		
5	684		
4	515		
3	352		
2	200		
1	68		
0			

Fig. 2.—Capacity Diagram

OUTSIDE PLATING

From keel to upper turn of bilge, .46 inch for $\frac{L}{2}$; at ends, .38 inch.
From bilge to strake below sheerstrake, .46 inch for $\frac{L}{2}$; ends, .38 inch.
Strake below sheerstrake, 41 inches by .46 inch for $\frac{L}{2}$; at ends, .38 inch.
Sheerstrake, 41 inches by .48 inch for $\frac{L}{2}$; at ends, .38 inch.
Propeller boss plate, .48 inch.
A, *B* and *C* strakes to be carried forward (of midship thickness) to collision bulkhead.

RIVETING SCHEDULE

Flat keel plate treble rivet laps throughout.
Shell plating treble rivet butt laps for ½ *L*.
Shell plating double rivet butt laps at ends.
Shelter deck sheerstrake treble rivet for $\frac{L}{2}$ to double at ends.
Shelter deck stringer plate treble rivet butt laps for ½ length.
Shelter deck stringer plate double riveted at ends.
Shelter deck tie plates double riveted butt laps throughout.
Main deck stringer plates double riveted butt laps.
Main deck plating, single riveted butt laps throughout.
Double bottom plating, center keelson treble riveted butt laps for $\frac{L}{2}$ to double at ends.
Margin and center strake of tank top double riveted throughout.
Tank top plating double riveted butt laps for $\frac{L}{2}$, single riveted at ends.
Spacing and diameters of rivets as per Lloyd's Rules.

ACCOMMODATIONS

On the bridge deck there is located a combination wheel and chart house 12 feet long and 9 feet 6 inches wide. At the forward end of the boat deck there is a wood house subdivided for the captain's stateroom, office, bathroom, a stateroom for the first officer and one for the second and

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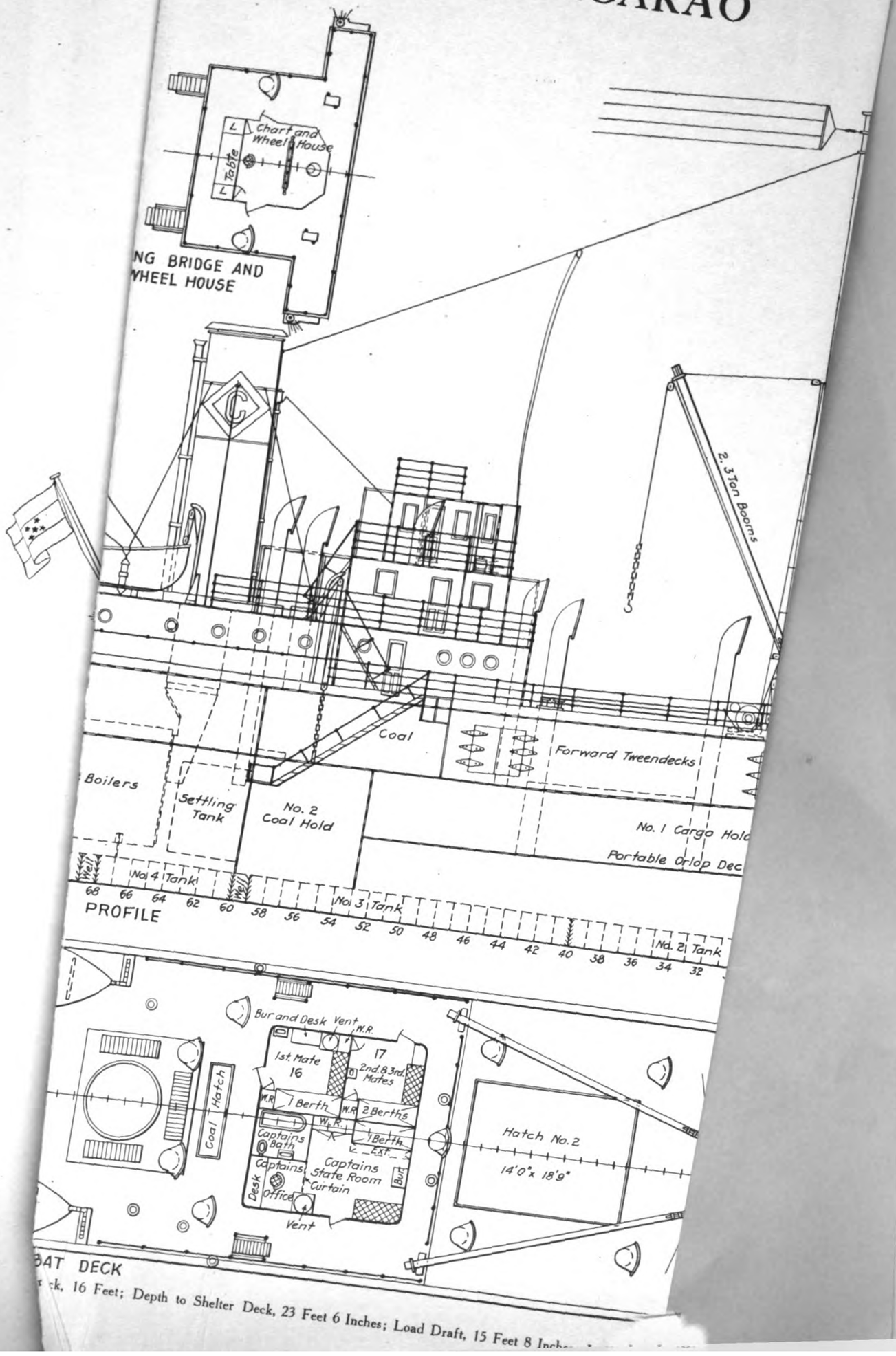
HIBUERAS AND NICARAO



ck, 16 Feet; Depth to Shelter Deck, 23 Feet 6 Inches; Load Draft, 15 Feet 8 Inch

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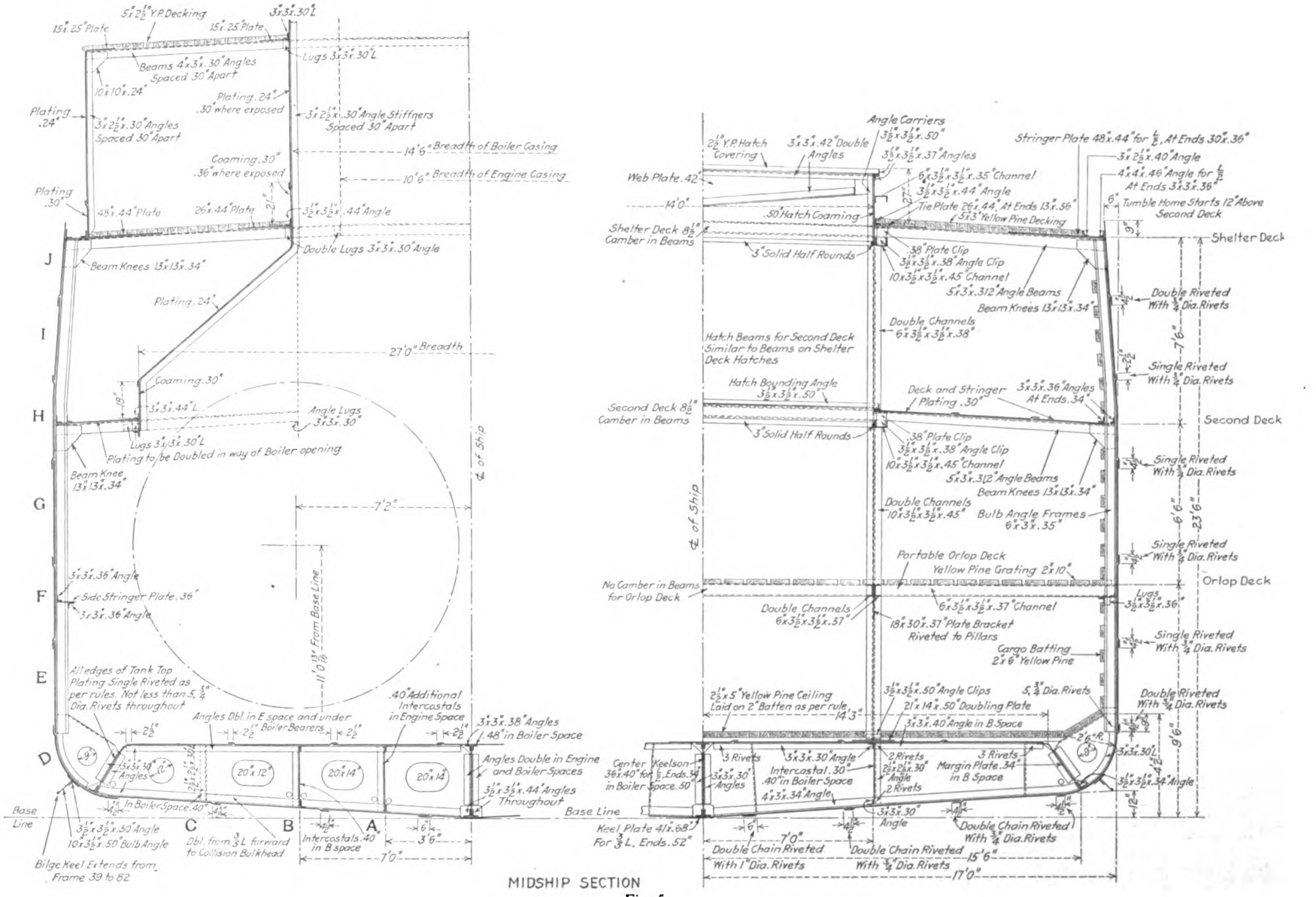
MIDSHIP SECTION
Beams 4"x3"x.30" Angles Spaced 30" Apart
Lugs 3"x3"x.30"L
Plating .24" .30" where exposed
3"x2½"x.30" Angle Stiffners Spaced 30" Apart
14'6" Breadth of Boiler Casing
10'6" Breadth of Engine Casing
Coaming .30" .36" where exposed
Double Lugs 3"x3"x.30" Angle
Beam Knees 13"x13"x.34"
27'0" Breadth
Coaming .30"
Angle Lugs 3"x3"x.30"
Plating to be Doubled in way of Boiler opening
7'2"
11'0 13/16" From Base Line
℄ of Ship
Side Stringer Plate .36"
All edges of Tank Top Plating Single Riveted as per rules. Not less than 5-3/4" Dia. Rivets throughout
Angles Dbl. in E space and under 2½" Boiler Bearers
.40" Additional Intercostals in Engine Space
3½"x3½"x.44" Angles Throughout
Base Line
Bilge Keel Extends from Frame 39 to 82
Dbl. from 3/4 L forward to Collision Bulkhead
Intercostals .40" in B space
7'0"
Angle Carriers
Stringer Plate 48"x.44" for ½ L, At Ends 30"x.36"
Web Plate .42"
14'0"
.50" Hatch Coaming
Tie Plate 26"x.44" At Ends 13"x.36"
Tumble Home Starts 12" Above Second Deck
Shelter Deck 8/8" Camber in Beams
3" Solid Half Rounds
Shelter Deck
Double Riveted With ¾" Dia. Rivets
Hatch Beams for Second Deck Similar to Beams on Shelter Deck Hatches
Double Channels 6"x3½"x3½"x.38"
Single Riveted With ¾" Dia. Rivets
Hatch Bounding Angle 3½"x3½"x.50"
Deck and Stringer Plating .30"
3"x3"x.36" Angles At Ends .34"
Second Deck 8/8" Camber in Beams
Second Deck
Double Channels 10"x3½"x3½"x.45"
Bulb Angle Frames 6"x3"x.35"
Portable Orlop Deck Yellow Pine Grating 2"x10"
No Camber in Beams for Orlop Deck
Orlop Deck
Double Channels 6"x3½"x3½"x.57"
18"x30"x.37" Plate Bracket Riveted to Pillars
Cargo Batting 2"x6" Yellow Pine
2½"x5" Yellow Pine Ceiling Laid on 2" Batten as per rule
21"x14"x.50" Doubling Plate
3"x3"x.40" Angle in B Space
Center Keelson 36"x40" for ½ L, Ends .54" in Boiler Space .50
Intercostal .30" .40" in Boiler Space
Margin Plate .34"
Keel Plate 41"x.68" For ¾ L, Ends .52"
Double Chain Riveted With 1" Dia. Rivets
Double Chain Riveted With ¾" Dia. Rivets
15'6"
17'0"

Fig. 5

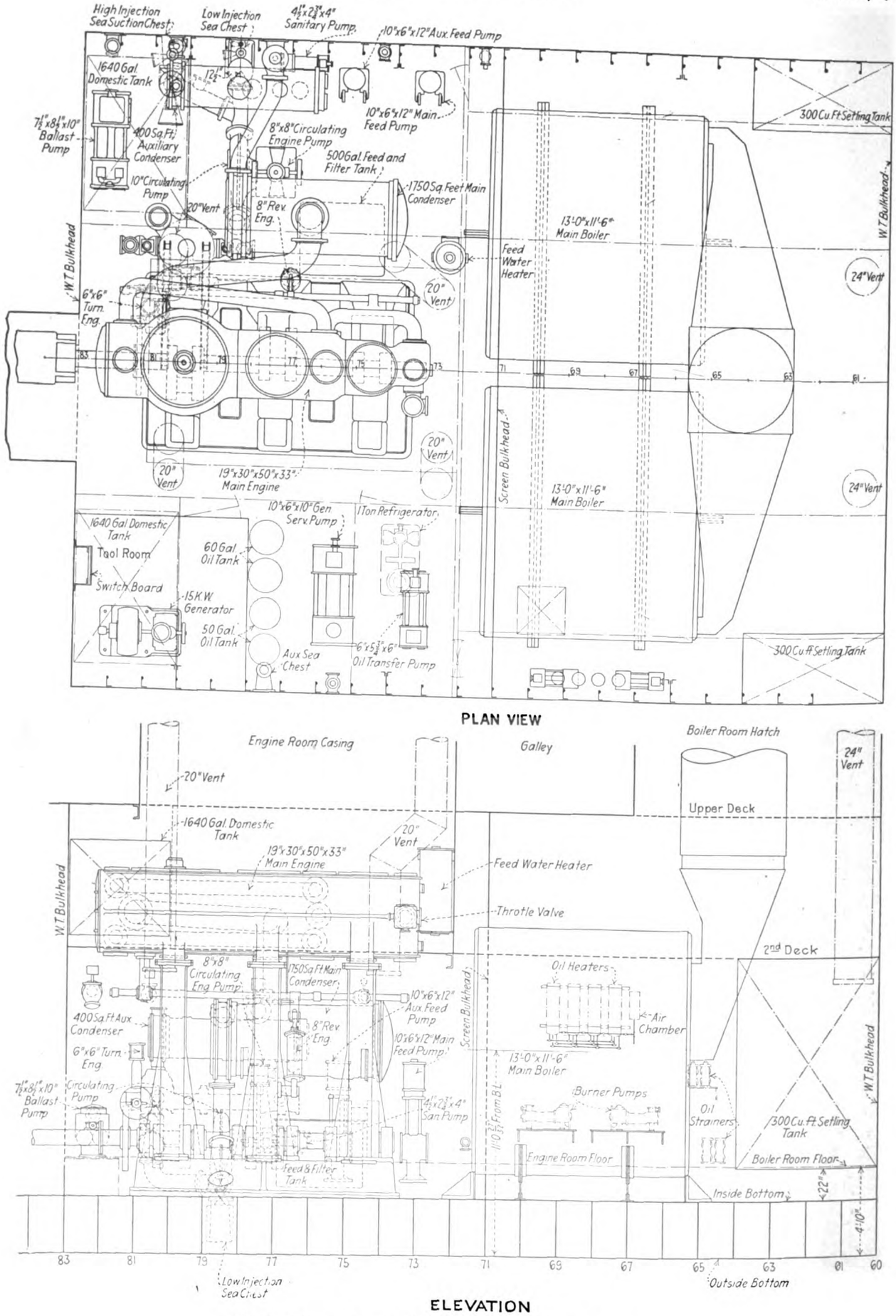

Fig. 6.—Plan and Longitudinal Section of Machinery Space

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third officers. At the after end of the boat deck there is located a wood house arranged for three passenger staterooms, toilet room, wireless operator's stateroom and wireless work room. A steel midship house on the shelter deck is subdivided for seven passenger staterooms, passengers' dining room, galley, pantry, storeroom, also staterooms for the steward, cooks, four engineers, officers' messroom, and bath and toilets for passengers and officers. The petty officers' quarters, together with the hospital, wash and toilet rooms, are located in a steel house at the after end of the shelter deck. The balance of the crew is quartered at the fore end of the vessel between the main and shelter decks.

PROPELLING MACHINERY

The main engine is of the vertical, inverted cylinder, surface condensing, three cylinder, triple expansion type, right hand when working in the ahead motion.

The particulars of the engine are as follows:

Diameter of high pressure cylinder, inches	19
Diameter of intermediate pressure cylinder, inches	30
Diameter of low pressure cylinder, inches	50
Stroke, inches	33
Working pressure, pounds per square inch	185
Indicated horsepower	1,150
Revolutions per minute	95

BOILERS

Steam is generated by two cylindrical, single end boilers of the Scotch type, 13 feet inside diameter by 11 feet 6 inches long, with a working pressure of 185 pounds per square inch. The effective heating surface is 1,820 square feet each, and there are three furnaces of the Morison suspension type in each boiler.

AUXILIARIES

The machinery installation also includes the following:

One condenser of the cylindrical type, fitted in the engine room, with a total cooling surface of 1,750 square feet.

One centrifugal circulating pump of double suction type, with 10-inch diameter pipe connections.

Two main and auxiliary feed pumps of the vertical double acting simplex type, composition fitted, having one 10-inch steam cylinder, one 6-inch water cylinder and a 12-inch stroke.

One horizontal donkey and fire pump, duplex type, composition fitted, 10-inch by 6-inch by 10-inch.

One horizontal, duplex type, ballast pump, 7½ inches by 8½ inches by 10 inches.

One horizontal sanitary pump, 4½ inches by 3¾ inches by 4 inches.

Two horizontal oil fuel pumps, duplex type, 4½ inches by 2¾ inches by 4 inches, installed for oil service. These pumps are connected to manifold boxes, meter, heaters, burners, etc.

One horizontal oil transfer pump, 6 inches by 5¾ inches by 0 inches, has been installed for the transfer of fuel oil from the double bottom to settling tanks.

One metropolitan double tube type injector, with 2½-inch connections.

HATCHES AND CARGO HANDLING

There are three cargo hatches which are half-encased with vertical gratings, thus permiting free air circulation. Through the open halves of the hatches a conveyor can be lowered for unloading the cargo, in this way eliminating the possibility of bruising and losing the fruit cargo. The hatches, which are on the shelter deck, have a tent-like covering to permit the hatch covers being left off in good weather, this arrangement greatly increasing the fresh air supply.

The three hatchways are served by six 3-ton capacity Oregon pine cargo booms, four being fitted on the foremast and two on the mainmast. The booms are served by six Clark-Chapman horizontal steam winches with double cylinders, 6 inches by 10 inches, two speeds, link reverse gear, of three-ton lifting capacity.

Three cargo ports 6 feet long by 5 feet 6 inches high are also provided on each side of the vessel, efficient watertight doors being provided to close them when under way.

VENTILATORS

The holds of the vessels are fitted for carrying fruit and are therefore well ventilated by natural draft, twenty-four 24-inch diameter ventilators and three 21-inch diameter sheet steel ventilators having been installed. These ventilators have strong steel plate coamings ½ inch thick and 30 inches high above the shelter deck. Handles for turning the ventilators are fitted, and the cowls and vent pipes exposed to weather are galvanized.

Other ventilators installed on the steamers are as follows:

One 9-inch diameter ventilator to shaft alley.

One 9-inch diameter ventilator to fore peak storeroom.

Two 9-inch diameter ventilators to after peak storeroom.

(*Continued on page 821.*)

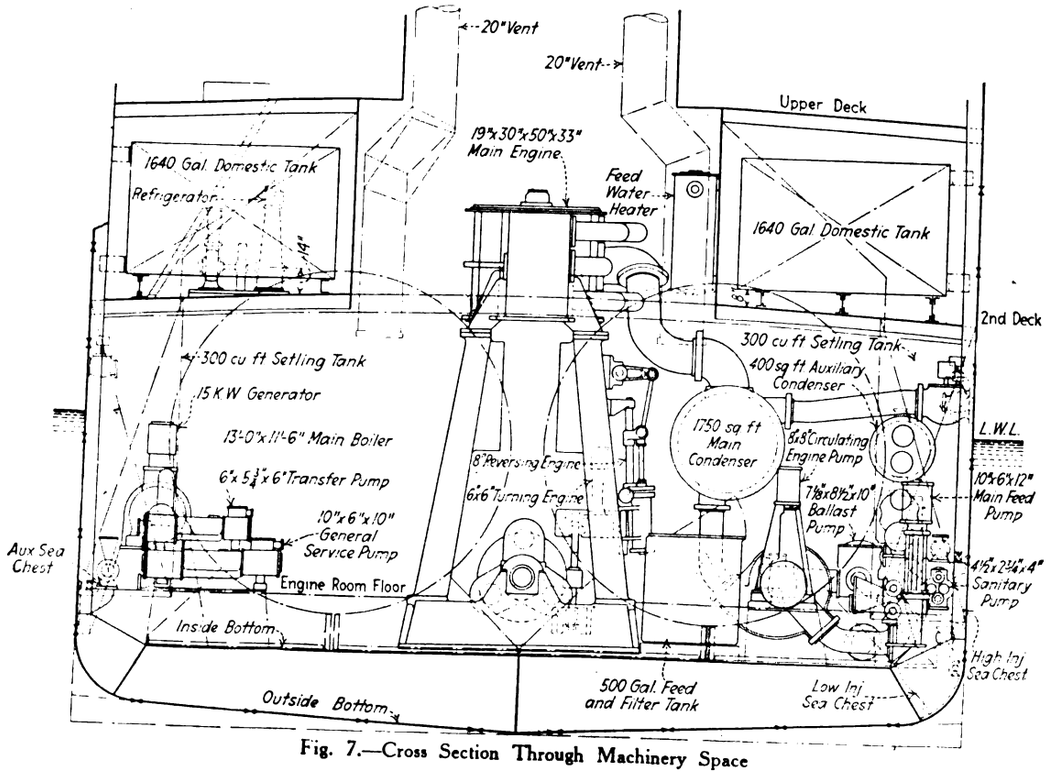

Fig. 7.—Cross Section Through Machinery Space

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Lake Bulk Freighter Horace S. Wilkinson

Single Screw, Shelter Deck Steamer of 12,120 Net Tons Deadweight Carrying Capacity Built by the Toledo Shipbuilding Company

AN exceptionally fine example of the shipbuilding art as carried on along the Great Lakes is the bulk freighter *Horace S. Wilkinson,* constructed by the Toledo Shipbuilding Company, Toledo, Ohio, for the Great Lakes Steamship Company.

This vessel has a deadweight carrying capacity of 12,120 net tons and is of the usual single deck type of freighter employed on the Great Lakes, with forecastle and after deck house, the main propelling machinery being located aft.

Principal Dimensions

The principal dimensions of the *Wilkinson* are as follows:

Length overall	600 feet
Length between perpendiculars	588 feet
Length, keel	580 feet
Breadth, molded	60 feet
Depth, molded	32 feet
Depth of double bottom at center	6 feet
Breadth of side tanks	6 feet

Quarters

A steel deck house erected upon the forecastle deck contains the captain's office, stateroom and bathroom and a spare stateroom for the owner or representative, and above this is the pilot house, which is also of steel construction. Quarters for the deck officers and crew are located on the spar deck under the forecastle. The engineers and cooks are quartered in a steel house located on the spar deck aft, which also contains the galley, refrigerator and messrooms.

Hull Construction

The hull of the vessel is built on the transverse system with a flat plate keel and a continuous spar deck. A main deck is fitted at the forward and after ends, the stringer plate being continuous to provide an upper boundary for the side ballast tanks.

Side ballast tanks 6 feet wide are fitted on each side of the vessel, extending from the shell at the bilge to the main deck stringer, and from the collision bulkhead to the forward coal bunker bulkhead. These tanks are subdivided to form three watertight compartments on each side of the vessel. The inboard plating of the side tanks is not stopped at the main deck stringer, but carried up to the spar deck forming a longitudinal strength girder. It is watertight to the main deck stringer.

A double bottom, 6 feet deep at the centerline, is fitted between the collision bulkhead and forward engine room bulkhead, extending from side tank to side tank forward of the forward coal bunker bulkhead and to the side of the ship under the coal bunker and boiler space. A double bottom is also fitted under the engine space extending to the side of the ship. The double bottom is 5 feet deep on the centerline at the forward end and 4 feet deep at the after end. The whole double bottom is divided by a watertight center girder and watertight floors into nine compartments for water ballast, the aftermost compartment terminating forward of the stuffing box bulkhead to allow for the engine room well.

The main cargo space extending from the collision bulkhead to the forward coal bunker bulkhead is divided into four holds by three screen bulkheads. Access to the cargo holds is provided by 35 cargo hatches 9 feet long fore and aft and 12 feet centers.

Telescoping hatch covers of 12½-pound plate are fitted and appliances are provided for operating them by hand or steam. Suitable fittings for securing hatch tarpaulins are also provided.

A chain locker, dunnage room, lamp room and paint locker are located on the main deck forward, and below these are the forward trimming tank and dark hold.

The main deck aft supports the steering engine and closes in the after peak tank located below.

A coal bunker of 500 tons capacity and extending the full width of the ship is located aft between the cargo and boiler space, the bottom of which is hoppered to deliver coal to the bunker doors. Above the spar deck a bunker house the width of the boiler house and 7 feet 6 inches high is built with a bunker hatch 8 feet by 36 feet in the top.

Joiner Work

The captain's office and stateroom and spare stateroom are fitted with paneled walls of quartered oak and ceilings of composition board forming panels. The captain's bathroom is paneled and finished in white enamel.

The pilot house, forecastle containing officers' and crew's quarters, wash rooms and hospital and the after deck house containing engineers' and stewards' quarters, bathrooms, etc., are finished in narrow V-joint oak walls and white painted pine ceilings.

No wood or composition decking of any kind is provided except a wood floor in the pilot house, and all woodwork of the walls is stopped 6 inches above the steel deck.

Propelling Machinery

Steam is generated in three Scotch boilers 13 feet inside diameter by 11 feet long over the heads, each one fitted with two furnaces 48 inches inside diameter and designed for a working pressure of 220 pounds per square inch.

A forced draft installation is fitted to the boilers consisting of a 36-inch fan in combination with a 6-inch by 6-inch blower engine.

The main engine is of the vertical quadruple expansion type with cylinders 21½, 30½, 43 and 61 inches in diameter by 42 inches stroke, arranged with the high pressure cylinder forward followed by the low, second intermediate and first intermediate pressure cylinders respectively. The high and first intermediate cylinders are fitted with piston valves and the second intermediate and low pressure cylinders with double ported slide valves, all valves being operated by the double bar Stephenson link motion.

The propeller is of the sectional type with four blades and is 15 feet 6 inches in diameter.

Auxiliaries

Included in the machinery installation are the following auxiliaries:

One mate's pump, of the horizontal duplex type, 6 by 4 by 6 inches.

One horizontal duplex fire pump, 14 by 7½ by 12 inches.

One horizontal duplex sanitary pump, 5¼ by 3¾ by 5 inches.

One single acting air pump, 40 by 12 inches, operated by a beam attached to the low pressure crosshead.

One 5½- by 10-inch bilge pump and one 4⅞- by 10-inch cooler pump actuated by an arm keyed to an extension of the air pump beam shaft.

One horizontal duplex 8 by 5 by 12-inch boiler feed pump.

One horizontal spiral coil, film feed water heater.

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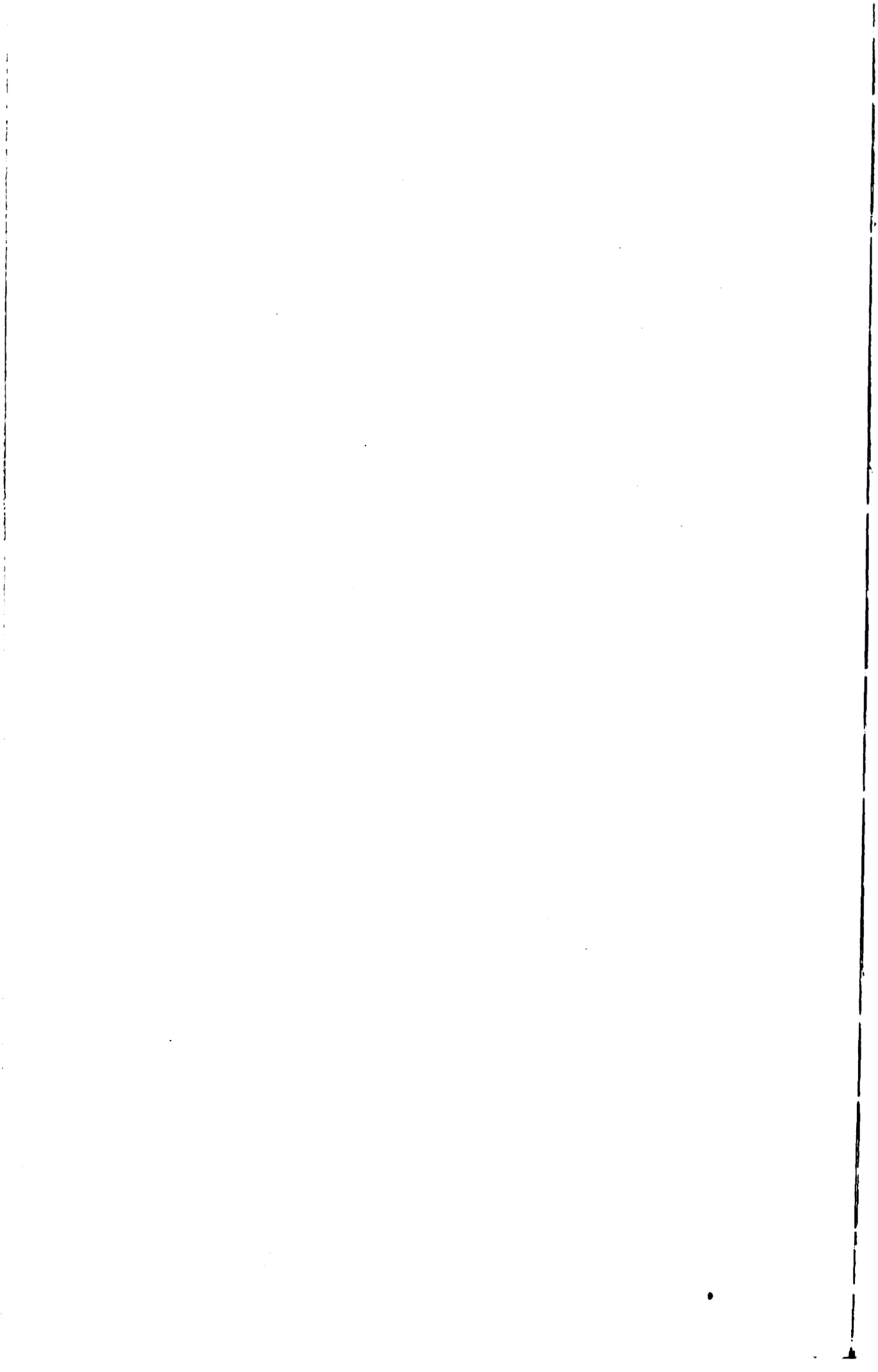

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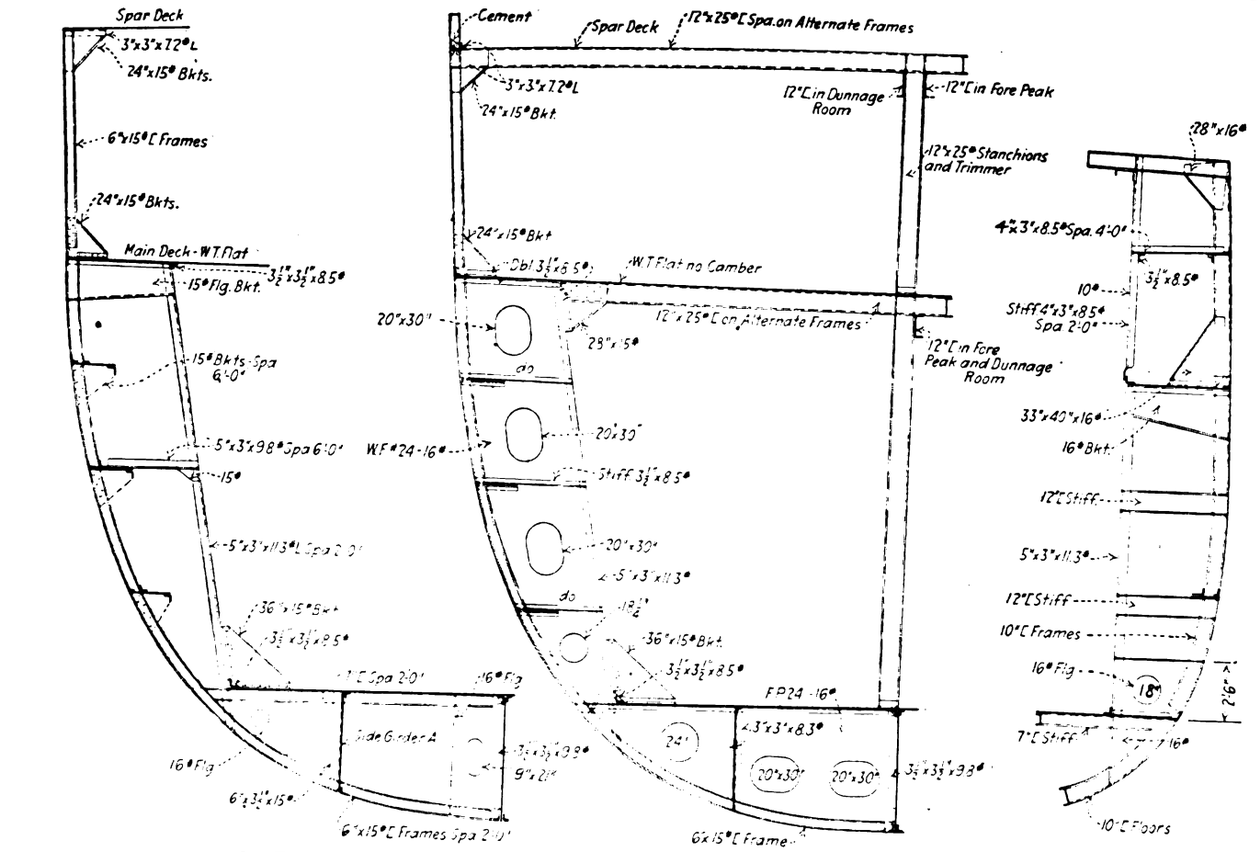


SECTION AT #23
FRAMING IN DARK HOLD AND FORE PEAK

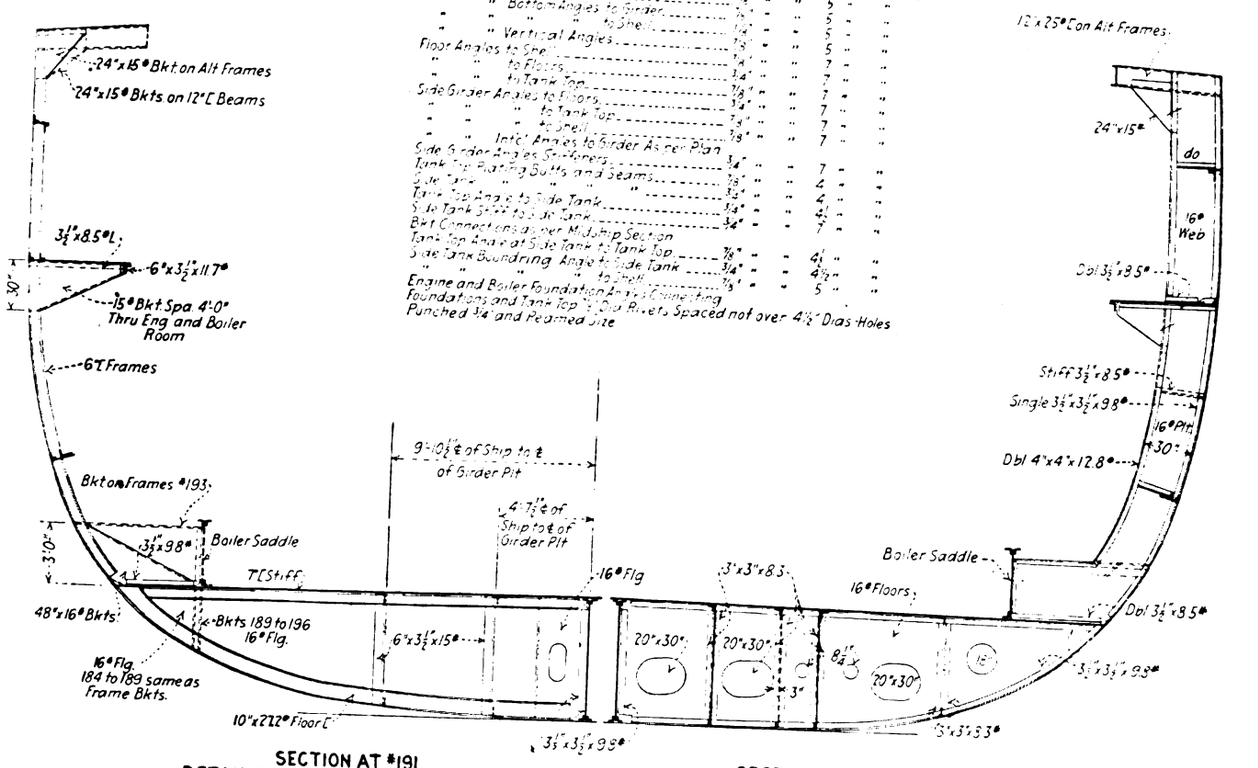
SECTION AT WEB FRAME NO. 24
LOOKING FORD

DETAIL OF BUNKER FRAMES
#177-#183

RIVETING NOTES

Center Girder Butts			Dia. Riv.	4 Dias. C to C	
" " Top Angles			"	5 "	"
" " Bottom Angles to Girder			"	5 "	"
" " " to Shell			"	5 "	"
" " Vertical Angles			"	5 "	"
Floor Angles to Shell			"	5 "	"
" " to Floors			"	7 "	"
" " to Tank Top			"	7 "	"
Side Girder Angles to Floors			"	7 "	"
" " " to Tank Top			"	7 "	"
" " to Shell			"	7 "	"
" " Int'l. Angles to Girder As per Plan			"	7 "	"
Side Girder Angle Stiffeners			"	4 "	"
Tank Top Planking Butts and Seams			"	4 "	"
Side " " " "			"	4 "	"
Tank Top Angle to Side Tank			"	4½ "	"
S. to Tank Stiff. to Side Tank			"	4½ "	"
Bkt. Connection in Center Midship Section			"	7 "	"
Tank Top Angle at Side Tank to Tank Top			"	4½ "	"
Side Tank Boundring Angle to Side Tank			"	4½ "	"
" " " to Shell			"	5 "	"
Engine and Boiler Foundation Angles Connecting Foundations and Tank Top			"	5 "	"

Punched ¾" and Reamed Site



SECTION AT #191
DETAIL OF FRAMES FROM 184-196

SECTION AT WEB #190
& FLOORS #187 TO 191

Fig. 3.—Framing and Riveting Details

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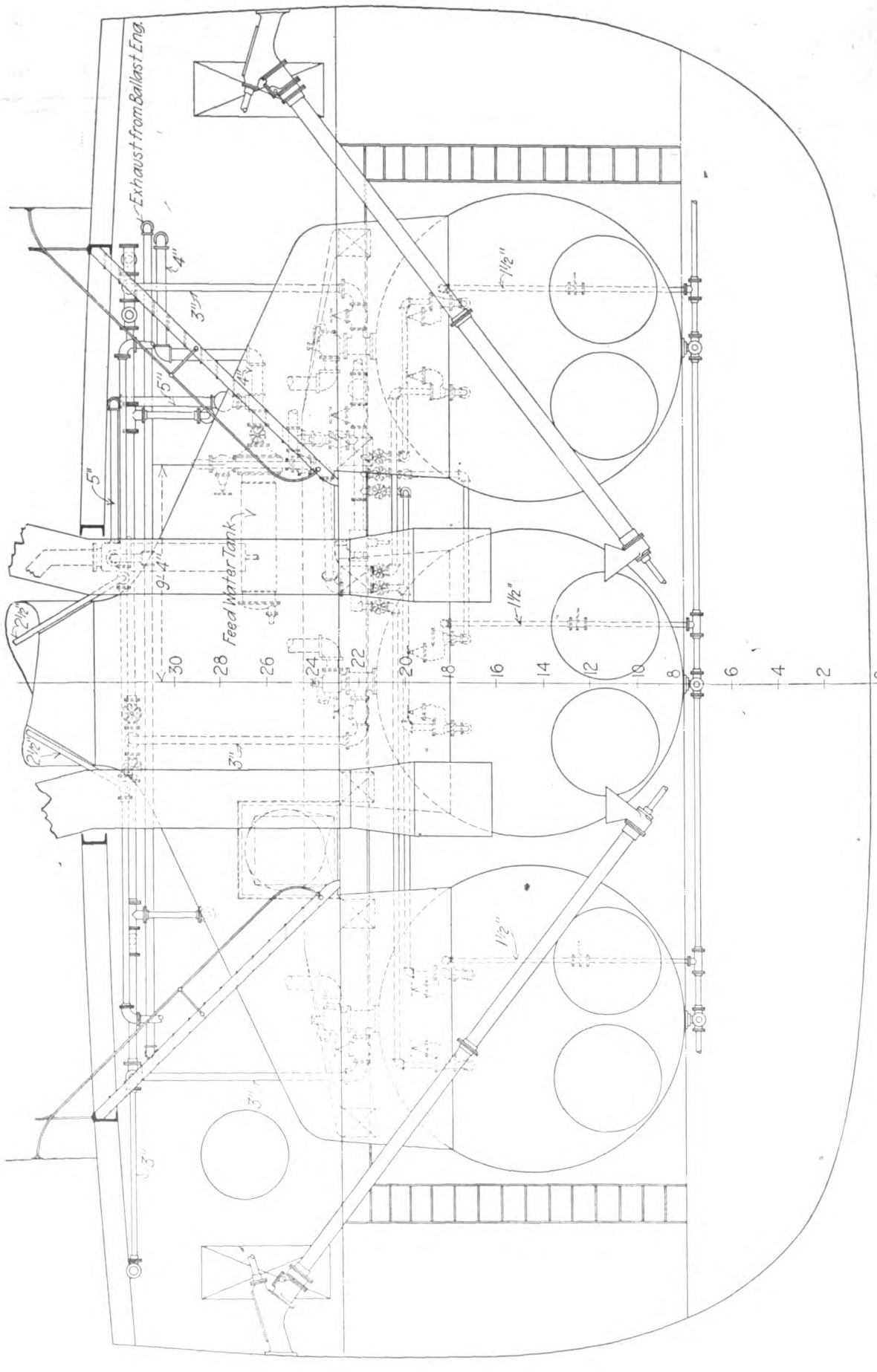

Fig. 4.—Section at Frame 184, Boiler Room, Looking Aft

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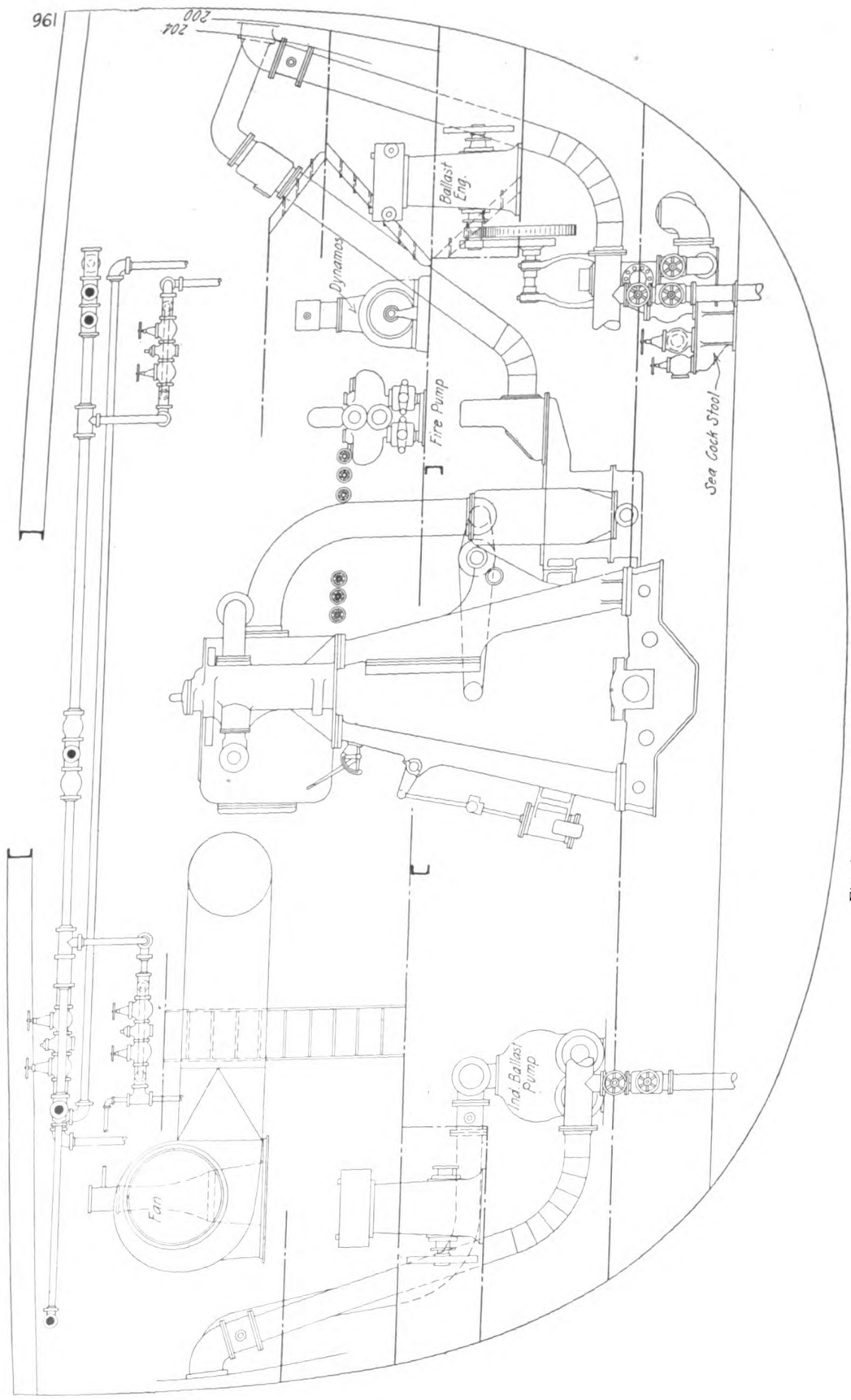

Fig. 6.—Section at Frame 196, Engine Room, Looking Aft

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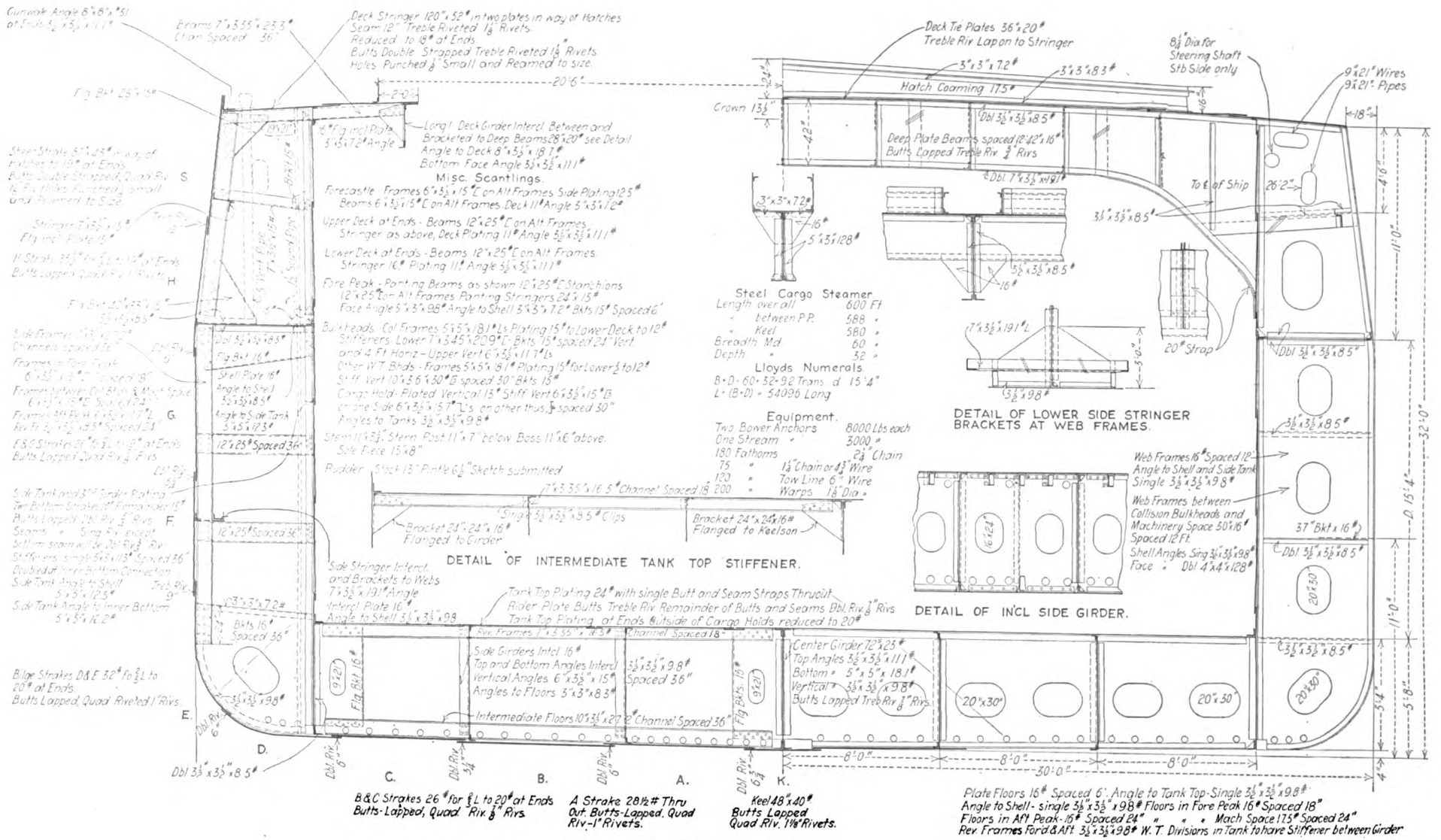
Deck Tie Plates 36"x20" Treble Riv Lap on to Stringer
Hatch Coaming 17.5#
Deep Plate Beams spaced 12'-42"-16" Butts Lapped Treble Riv 7/8" Rivs
To ℄ of Ship
Steel Cargo Steamer
Length over all 600 Ft
" between P.P. 588 "
" Keel 580 "
Breadth Md 60 "
Depth " 32 "
Lloyds Numerals
B+D=60+32=92 Trans d 15'4"
L÷(B+D)=54096 Long
Equipment.
Two Bower Anchors 8000 Lbs each
One Stream " 3000 "
180 Fathoms 2 1/4" Chain
75 " 1 1/4" Chain or 4 3/4" Wire
120 " Tow Line 6" Wire
200 " Warps 18" Dia "
DETAIL OF LOWER SIDE STRINGER BRACKETS AT WEB FRAMES.
DETAIL OF INTERMEDIATE TANK TOP STIFFENER.
DETAIL OF INCL SIDE GIRDER.
Misc. Scantlings.
Plate Floors 16# Spaced 6' Angle to Tank Top-Single 3 1/2"x3 1/2"x9.8#
Angle to Shell-single 3 1/2"x3 1/2"x98# Floors in Fore Peak 16# Spaced 18"
Floors in Aft Peak-16# Spaced 24" " " " Mach Space 17.5# Spaced 24"
Rev. Frames Fore & Aft 3 1/2"x3 1/2"x9.8# W.T. Divisions in Tank to have Stiffener between Girder
B&C Strakes 26# for 3/4 L to 20# at Ends Butts-Lapped, Quad Riv. 7/8" Rivs.
A Strake 28 1/2# Thru Out. Butts-Lapped. Quad Riv.-1" Rivets.
Keel 48"x40# Butts Lapped Quad Riv. 1 1/8" Rivets.

Fig. 7.—Midship Section

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Two ash guns located in the boiler room, one on each side of the vessel.

DECK MACHINERY

One 10-inch by 14-inch spur geared windlass with wildcats of suitable size for handling 2¼-inch chain is located forward on the main deck.

WINCHES

Seven deck winches of the double cylinder 8-inch by 10-inch single drum type with link motion reversing gear are provided as follows:

Two located forward of hatches and two aft of hatches on the spar deck, one with gypsy head located on the spar deck at the stern of the vessel and two with gypsy heads located in the windlass room.

Four double cylinder 6-inch by 5-inch hatch winches are also provided, two being located forward of the hatches and two aft of the hatches on the spar deck.

The steering gear consists of a 10-inch by 8-inch screw steering engine of the combined hand and steam type, located on the main deck aft and operated by a brass wheel and stand fitted in the pilot house.

Provision is also made for operating the steering gear in emergency from the top of crew's deck house aft by means of suitable gear and clutches.

BALLAST SYSTEM

The ballast system consists of fourteen single acting trunk pumps 16 inches by 12 inches, driven by two double high pressure engines with cylinders 8 inches diameter by 8-inch stroke.

Seven pumps are located each side of the center of ship, and each pump is connected to a compartment in the double bottom or side tanks by a separate pipe 7 inches in diameter. A double manifold is fitted between pumps and the system is cross-connected by valves and fittings in a manner which will allow for filling or emptying each or all of the compartments or for pumping from any one or more compartments to any others.

Two 14-inch filling valves are provided which are located below the light waterline.

In addition to the trunk pumps a horizontal duplex ballast pump 12 inches by 18 inches by 18 inches is provided and connected to the manifold the same as the pump trunks.

All the ballast pumps discharge overboard at about the 25-foot waterline.

DRAINAGE SYSTEM

Provision is made for draining the holds and machinery spaces as follows:

Two drain valves are located in the tank top in the dark hold forward, one fitted on each side of the vessel. These valves are fitted with reach rods so that they can be operated from the dunnage room above.

The forward cargo hold is drained by a well through the after collision bulkhead with steam syphons leading overboard, the steam valves for the syphons being located in the dunnage room. Two gate valves are also provided between the forward cargo hold and the dark hold, arranged to be operated from the main deck.

A drain hole 6 inches square is located on each side of the ship in the screen bulkheads between the cargo holds.

The after cargo hold is drained by a cast iron well through the forward coal bunker bulkhead and tank top on each side of the vessel and fitted with an 8-inch suction to the ballast manifold in the engine room.

Drains from the boiler room through the bulkhead to engine room above the tank top are fitted with gate valves.

Steam syphons are also fitted in the engine room well and one on each side in the boiler room.

VENTILATION

Two 30-inch ventilators are provided for the boiler room and four 20-inch vents in the engine room, all fitted with turning gear operated from below.

The crew's quarters are ventilated by 10-inch vents fitted with dampers handled from the inside.

ELECTRICAL INSTALLATION

The vessel is fitted with a complete electric lighting system and intercommunicating telephone and call bells.

An electric whistle is also provided and oscillating electric fans are installed in the captain's, owner's, chief engineer's and steward's staterooms, and the galley, dining and mess rooms.

Two 15-kilowatt and one 7½-kilowatt direct connected generating sets make up the installation.

The *Horace S. Wilkinson* is one of the largest and best appointed bulk freighters operating along the Great Lakes, and the builders and owners may justly feel proud of her.

The Outfitting Dock

BY RALPH L. PADDOCK

IT is a debatable question as to just how much machinery should be installed while the hull is on the ways, and because of the lack of planning for this work it is seldom known just how much will remain to be done at the outfitting dock. Therefore the amount of work at that point will vary considerably, and when such variation occurs it hinders any attempt at a maximum output. The deleterious effect of this varying condition is also seen in hundreds of manufacturing plants where one department's output varies periodically with the succeeding department's. For when department *B* finds the supplies which come from department *A* piling up, a condition which causes *A* to slow down, it puts forth efforts to catch up. It no sooner begins to do this than *A*'s output begins to drop, and *B*, fearing a shortage of work because of its increased and *A*'s decreased output, desists from further efforts, and now with the conditions reversed another surplus begins to accumulate. This condition prevents maximum output.

To reach some conclusion as to the equipment of an outfitting dock, it must be assumed that the number of hulls launched per month is nearly constant and the amount of machinery and outfiting is about the same for each weight and type of ship. With this assumption it is possible to estimate the size and equipment of an outfitting dock which should be so proportioned to the needs of the yard that the space and machinery will at all times be occupied. Unused space bears taxes and interest the same as used space, and is a loss the same as idle or non-producing machinery.

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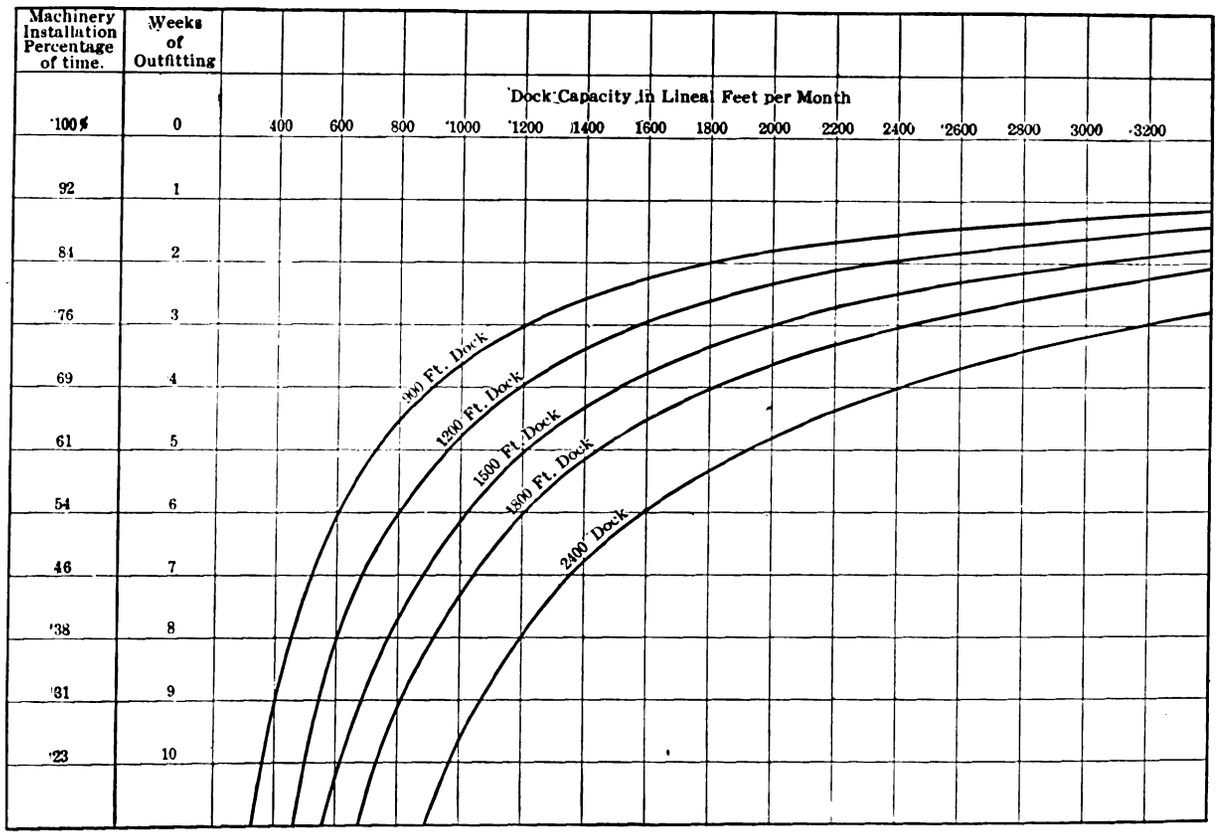

Fig. 1.—Chart Showing the Length of Outfitting Dock Required for Various Dock Capacities and Weeks of Outfitting

When the outfitting dock is already built and there is a congested condition, the question arises whether the congestion is actual or imaginary. If it is imaginary, the fault lies with the planning department in not carrying out its schedule. If it is actual, it is because of improper planning, insufficient space or equipment or lack of both space and equipment. The effect due to labor shortage is intentionally omitted, but should the shortage of dockage and equipment be the cause, it may be relieved materially by installing the boilers and engines before instead of after launching.

Launching with the boilers and engines installed is not new in this country, nor in Italy, where it was done over fifteen years ago with an end-launched ship. The installation of the heavy machinery at the ways would eliminate the heavy cranes at the outfitting dock and very likely require no heavier cranes at the ways. This prelaunching installation results in smaller outfitting docks.

The factors which govern the frontage of outfitting docks are:

(1) Length and beam of ships.
(2) Number of hulls launched per month.
(3) Number of weeks outfitting at dock.

Fig. 1 shows curves giving the length of dock for varying amounts of lineal feet of hull per month when the number of weeks required for each boat at the outfitting dock is given. The latter is also expressed in the percentage of time equally distributed from the starting to the finishing of the machinery installation. The percentage of machinery installation has generally referred to the valuation or weight of the machinery, but here it refers to time in days.

As an illustration, assume a ten-way yard launching a 10,000 deadweight ton, 400-foot ship from each way every 100 days, or 2.5 ships per month with boilers and engines already installed, and that each ship after four weeks at the outfitting dock would be ready for her trial trip. At this rate there will be 1,000 lineal feet of hull ready each month for the outfitting dock. The length of dock frontage to meet this output may be determined by referring to Fig. 1. Follow down the line representing 1,000 lineal feet of ship per month until it intersects the four weeks or 69 percent machinery installation line. Through this point would pass the 1,000-foot curve, but as it is impossible to erect one-half of a ship, the space must be sufficient to accommodate three ships and therefore a 1,200-foot dock will be required.

Could the time at the outfitting dock be reduced to three and one-half weeks, a 900-foot dock would be sufficient provided the units (the ships) were of such length that they could occupy the entire frontage. But in this case, as they are not, the dock's length must be a multiple of the unit length and remain 1,200 feet. The next reduction in length would be to 800 feet, and with this frontage each ship must be finished at the dock in about one day more than three weeks, so as to make way for those following. The total frontage may be reduced by placing the ships abreast, in twos or threes, if there is sufficient room in the wet basin, or if the property line extends far enough away from a dock running parallel with the shore line.

In a yard where the boilers and engines are installed after launching and all other conditions remain the same as those mentioned, about 43 percent of the total installation time will be spent at the outfitting dock. This is slightly more than twice as long as in the former case and would require a dock twice the length, or, as indicated in Fig. 1, a 2,400-foot dock. This length may be reduced one-half, or to one-third, by mooring the ships abreast as already mentioned.

It has been assumed that the installations will attain the same speed at the outfitting dock as on the ways. This, however, is not the case. A hull on the ways is more

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accessible, and of most importance is the impelling force which drives the men to work faster there than at the outfitting docks. This may be attributed to the interest manifested to have the ship launched as soon as possible. Therefore, the results attained in installing the boilers, etc., before launching will show up to better advantage than herein mentioned.

The machinery has been referred to as 43 percent installed. This percentage quite generally refers to the value or weight, whereas here it refers to the time required. For instance, the list covering the machinery installation of a 9,000 deadweight ton cargo ship may comprise as many as seventy-five items, each item representing a certain operation upon which time is expended. By summing this up it would amount to about 680 days, of which 100 are allotted to the time at the outfitting dock. This does not mean that the ship remains 580 days on the ways and 100 more at the outfitting dock, for there may be many different operations going on at the same time and the fourteen operations at the outfitting dock, were they done simultaneously, would be completed in seven days. But as not all of these require this time, the one requiring the longest time will determine when the ship will be ready for its trial trip.

Table I establishes a time relation for all the principal groupings of machinery installation. The figures under "Boilers and Engines Installed on Ways" have been taken from a planning chart, whereas those in the columns under "Boilers and Engines Installed at Outfitting Dock" are deduced from the other columns. For different yards this table will have different values, but here it illustrates the effect upon the equipment and length of outfitting dock when the boilers, etc., are installed either before or after launching. Any shipyard, however, may make up its own tables in the following manner:

(1) List all the material to be installed and set opposite each the number of days required for installation.
(2) Classify those under the headings given in the list with the days added.
(3) Obtain the daily percentage by dividing by the total and multiplying by one hundred.
(4) Figure the percentage for each item by multiplying the number of days with the daily percentage. The percentages indicating the amount of time spent on each operation before the launching and after the launching depend upon what has been planned. With these figures available the total period column may be completed.

The crane at the outfitting dock should be able to lift the heaviest single piece of machinery with ease, but since it is seldom called upon to lift these pieces, many of the valuable operating conditions such as speed and movements found in the costlier cranes may be dispensed with. From an examination of seventy-four shipyards the shear leg crane predominates.

As the remaining installations on the ship consist largely of electric wiring, piping and plumbing, a building should be located on the outfitting dock to hold the machinery for this work and provide storage for supplies. The machinery should consist of pipe fitters' machines, a machine lathe, sensitive drill presses and several wood working machines. The material stored would include pipe flanges, electrical supplies, nautical instruments and other articles. As it would be used as a service station it should have a telephone connection with the rest of the yard.

In order that locomotive cranes and supplies in quantities may be available on the dock, there should be a standard gage railroad track running the entire length of the pier and parallel to the dock whereby it may serve the entire waterfront. The dock should be well supplied with electricity and air outlets at points convenient for use on the ships.

With the outfitting dock arranged to meet definite conditions obtained through proper planning, the varying quantity of work will remain at a minimum. Also the dock will at all times have its frontage occupied with ships.

Table I.—Percentages of Machinery Installations when Boilers and Engines are Installed either on the Ways or at the Outfitting Dock

List of Materials	Boilers and Engines: Total Installation Period		Installed on Ways		Installed at Outfitting Dock	
			Before Launching	After Launching	Before Launching	After Launching
	Days	Per-cent.	Per-cent.	Per-cent.	Per-cent.	Per-cent.
PIPING:						
Steam	35	5.15	5.15	....	....	5.15
Exhaust	15	2.21	2.21	....	....	2.21
Sanitary / Bilge / Service	107	15.73	14.26	1.47	14.26	1.47
PUMPS	50	7.35	6.48	.88	6.48	.88
Line shafting, bearings, propellers, stern tube	27	3.97	3.97	....	3.97	....
BOILERS:						
Uptake and Stack coverings, pipe and boiler	36	5.29	4.32	.88	....	5.29
Condenser	20	2.94	2.35	.59	....	2.94
Forced draft, fan and duct	8	1.18	1.18	....	1.18	....
Evaporator and feed-water heater	12	1.76	1.76	....	....	1.76
TANKS, Oil, Water, sanitary	21	3.09	3.09	....	1.50	1.59
TURBINE	18	2.65	2.65	....	2.65	....
Generator switchboard and Lighting equipment	21	3.09	3.09	....	....	3.09
Steering Engine and Gear	52	7.64	3.96	3.68	....	7.64
Plumbing, Fittings	28	4.12	4.12	....	4.12	....
Deck Winches and Windlasses	15	2.21	.88	1.32	.88	1.32
Refrigerator set	9	1.32	1.32	....	....	1.32
Fuel Oil System	8	1.18	1.18	....	....	1.18
Engine room railing	42	6.17	6.17	....	6.17	....
Telegraph	12	1.76	1.76	....	....	1.76
Tools and Outfit	24	3.53	.88	2.65	....	3.53
MISCELLANEOUS	3	.44	....	.44	....	.44
	117	17.20	15.43	1.76	15.43	1.76
	680	99.98	86.31	13.67	56.64	43.33

British Built Cargo Steamer Amstelland

AMONG vessels completed in British yards during the past few months are several for foreign account intended for special freight service. Of these the *Amstelland*, built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at the Wallsend shipyard was completed in August, and after a successful trial turned over to her owners, the Koninklijke Hollandsche Lloyd, of Amsterdam.

The *Amstelland* is a fine-line cargo carrier having a cruiser-shaped stern. It is designed to carry nearly 13,000 tons deadweight at a draft of 28¼ feet. She has an overall length of 490 feet and a beam of 61½ feet. The cellular double bottom is arranged for either oil fuel or water ballast. The propelling machinery and boilers were built at the Neptune Engine Works of Messrs. Swan, Hunter & Wigham Richardson, Ltd. The boiler unit consists of five cylindrical boilers designed for a working pressure of 200 pounds per square inch under forced draft and fitted for burning either oil or coal. The boilers are also equipped with Robinson marine type superheaters. The propelling unit consists of a set of double reduction gear turbines of Westinghouse-Rateau type driving a single propeller.

Two of the holds in the ship are refrigerated for carrying frozen meat. The three other holds of the vessel are for general cargo.

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The Functions of the Merchant Ship*

Basic Factors Upon Which the Usefulness of a Ship Depends—Where Time Can Be Saved in Delivering Cargoes

BY SIR NORMAN HILL, BART.

A SHIP is a wasting property; its life is limited to, let us assume, twenty-five years, and at the end of that time it passes into the hands of the ship-breakers. It will then cease to be a ship and become merely a mass of material which has been wrought for one purpose and which can be applied to other purposes only by the expenditure of considerable labor. It follows that the economic value of the ship to the shipowner is represented by the sum of the excess of freights over payments which begin from the time the keel is laid down to the time when the vessel passes into the ship-breaker's hands; and to justify the expenditure the freights received must not only cover working expenses and provide a reasonable return on the capital employed, but they must also be sufficient to replace that capital. The freights are earned in return for the services rendered in delivering all the cargoes that are carried during the ship's life, and therefore the economic value of the ship to the shipowner is determined *first* by the total number of freights earned, that is, by the total number of cargoes delivered, and, *secondly*, by the total cost incurred in delivery of those cargoes.

To oversea commerce and to the interests of the producers and consumers in the world which that commerce serves, the economic value of the vessel is determined by the same factors, but while the shipowner is concerned with the sum of the excess of freight over payments, the producers and consumers are primarily concerned with the sum of the cargoes delivered. Cost of transport is no doubt of importance, but it is relatively a small matter compared with abundance of supplies in relation to demand.

Regarded, therefore, from the point of view of the shipowner, the producer and the consumer, the one and only function of the merchant ship is to deliver cargoes and delivery connotes:

1. Loading.
2. Transportation in safety.
3. And discharging in good condition.

What cargoes are to be delivered and through what ports such cargoes are to pass is determined by the flow of overseas commerce, which is in the main governed by the needs of the consumers. Those are matters over which the shipowner has no control—it is for him to satisfy the needs as they arise.

As oversea commerce is now carried on, a ship spends about one-half of its life at sea under steam and the other half in port, engaged in loading and discharging and in overhauls and repairs. The time spent by the ship in port has been described as lost time, but that surely ignores what is the function of the ship, which is to deliver cargoes at the points at which they are needed, not merely to carry such cargo about on the sea. It follows that the loading and discharging are just as necessary as the transportation of the cargoes, and the time occupied in each of these necessary operations must be reduced to the minimum if the maximum number of cargoes is to be delivered. Thought should not be concentrated on the saving of time in only one of these operations. The overall efficiency of a ship is therefore composed of several factors, and after safety the most important of all is time, because in measuring efficiency it is the life of the ship and the sum of the cargoes she will carry during that life that must be always kept in view.

Now in what way can the science of the naval architect best contribute to this overall efficiency?

Safety comes first. What oversea commerce needs and is ready to pay for is delivered cargoes; it profits nothing from lost cargoes. Loss is waste, whether it falls on the merchant, the shipowner or the underwriter, and it has to be paid for ultimately by the consumers.

Very careful consideration has been given to the factor of speed and its relation to the cost of its production and the cargo holding capacity of the ship. I speak subject to correction, but it would appear that on balance little is to be gained from increasing the speed with which the voyage is made. Certainly, looking back over the last thirty years, there has been but a small increase in the average speed of the steamships of the British mercantile marine. The average speed of all steam vessels belonging to the United Kingdom, including both those above and below 12 knots, was, in 1894, 10.4 knots, and in 1908, 11 knots. Taking all the available information into consideration, I do not think that the average speed of the steamships of the British mercantile marine has increased during the last thirty years by more than about half a knot. If time is to be saved it must, I think, be in port.

In designing the most efficient discharging and loading appliances for the ship, such as winches and derricks, much has been done. In designing vessels capable of loading and discharging with the minimum of labor and in the shortest possible time, particular classes of cargo, such as oil in bulk and coal, much more has been done; but in many ports the ship's appliances do not play an important part in the loading and discharging, and ships designed for the carriage of special commodities and no other will not meet the general needs of oversea commerce. The utmost despatch is required in all ports; the great majority of ships must be able to carry not only cargoes outwards, but also homewards, and frequently on cross voyages between the outward and homeward voyage, and the cargoes on all these voyages will never be of only one class of commodity.

In studying the problem how time in port can be saved, there are certain marked tendencies in the development of the ocean oversea trades to be borne in mind. The first is the growth in the size of the ocean-going steamship. The second is the concentration of the voyages on a limited number of ports, which has followed largely on the growth in the size of the ships. In the United Kingdom this concentration is so marked as to call for careful consideration. It will be found that 75.6 percent of our overseas imports, other than iron ore, and 78.1 percent of our overseas exports, other than coal, were in 1913 handled in twelve ports of the United Kingdom. The third tendency in the development of ocean oversea trade is the growth of parcel shipments and the decrease of whole cargoes. General trade, both import and export, is depending more

* From a paper read at the spring meetings of the sixty-first session of the Institution of Naval Architects, Liverpool, England, July 6, 1920.

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and more on the liners carrying mixed cargoes. It is shipped to meet almost the daily needs of individual importers, instead of being left for the purposes of transit in the hands of merchants.

The effect of all these tendencies is to concentrate the general ocean oversea trade on the ports which can offer the best accommodation to the bigger ships, both as regards berthing and the handling of their mixed cargoes; but all this concentration tells against the quick turn round of those ships in the big ports. It is no easy matter to keep pace with the necessities of the ships by adding to the accommodation in the big ports, and it is a still more difficult matter to increase the carrying power of the railways by which those ports are served. I cannot pretend to be able to offer suggestions as to the manner in which ships should be built and equipped so as to enable them to be loaded and discharged more quickly, but I do believe that it is in national interests an urgent problem, calling for most careful consideration. I realize that much of the work can only be done in collaboration with the ports; but working hand in hand with the ports and in especial with the big ports upon which the big ships are concentrated, cannot radical improvements be introduced? Are winches the last word in cargo handling appliances?

Design and Construction of Merchant Ships as Affected by Recent War Experience*

BY PROFESSOR J. J. WELCH, D. SC.

When, during the late war, the enemy adopted the policy of torpedoing mercantile vessels, the Board of Trade commenced an investigation into the circumstances attending the damage or loss of such vessels by mine or torpedo, with a view to determining whether the experience so gained suggested modifications of design or details which would conduce to greater safety of life at sea. The author was asked to undertake this investigation, and some of the information gained is given in this paper by permission of the Department named.

REPORTS from captains and other officers, detailing what occurred at the time of the casualty and afterwards, were received for a very large number of ships, these reports being supplemented later by answers to a *questionnaire* sent out by the Board of Trade to any on board at the time who could throw any light on the subject. These questions, being directed to specific points, were the means of adding materially to our knowledge. Further, in a large number of cases information was obtained from owners giving particulars of form of ship, disposition of bulkheads, freeboard, metacentric height, etc., enabling a detailed analysis to be made in such cases. From the mass of information available it is possible to arrive at some general conclusions as to subdivision and to suggest modifications as to details.

One point brought out by this analysis is the reasonableness of the figures for permeability suggested by the 1914 Bulkhead Committee. Thus in nearly every case when analysis based on these permeabilities showed that a vessel damaged in machinery or cargo spaces should float or sink, the analysis was confirmed by experience. Moreover, when analysis in connection with general cargo spaces showed that the vessel should have just floated, or should just sink, the actual results have been in accord. In other cases of damage to cargo holds, analysis based on 60 percent permeability showed that the vessel should have sunk, whereas, in fact, she remained afloat. In such cases, however, the cargo was not of a "mixed" or general character, but of homogeneous nature such as grain, which is known to have a lower permeability than 60 percent, and the discrepancy mentioned was thus adequately accounted for.

DAMAGE CAUSED BY TORPEDO OR MINE

As to the nature and extent of damage caused by a torpedo or mine, when a vessel is struck in way of a cargo hold, the hatches are usually blown off, and as the hatchways are of considerable size, the relief of the pressure set up by the explosion must be very great, tending to minimize the damage below. It seems probable, although the evidence does not justify dogmatism, that as the hatchways in large and fast steamers are often relatively small, the pressure would not be relieved so quickly in such vessels as in others, and increased damage below and to decks, as compared with purely cargo vessels, is likely to result. The irregular holes blown in the side or bottom plating varied greatly in size, and, in cases where holds were empty, or nearly so, splinters of plating, rivets, etc., were likely to be driven through the opposite side and the boundary bulkheads of the compartment attacked. Pump suction pipes leading to other compartments have often been fractured, and pipe, communication and shaft tunnels passing through mined or torpedoed compartments have been damaged, thus opening other spaces to the sea. The average size of hole for both torpedo and mine damage may be taken as about 30 feet by 20 feet. From this it follows that to make a vessel reasonably safe against attack from a single torpedo or after striking a mine, the ship should be capable of remaining afloat with any two holds open to the sea, while the minimum length of hold should be not less than, say, 40 feet to 45 feet, so as to avoid the possibility of two bulkheads being injured at the same time. These conditions can be conveniently arranged for in a vessel of about 450 to 500 feet in length.

The first effect on a damaged ship was to produce a heel temporarily to the damaged side, due to the influx of water on that side, which heel was eliminated or reduced as the water became uniformly distributed across the ship. In some cases the loss of metacentric height due to the loose water admitted to holds was sufficient to render the ship initially unstable, and heeling resulted from this cause, such heeling being diminished, or the ship even regaining the upright, as the water in the holds reached the level of the water outside. This follows from the well-known fact that the loss of initial stability is gener-

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ally greatest when the quantity of water admitted is relatively small. Treating the question as one of loss of buoyancy, with constant displacement, the position of C.G. of ship remains fixed throughout, while the variation in location of metacenter depends upon the rise of the center of buoyancy and the length of B.M. At an early stage of the inflow the position of C.B. remains practically unaffected, while the diminution in the length of B.M. is given by $\frac{\mu i}{V}$ with the usual notation, μ being the fractional permeability of the damaged compartment. The value of i, the total moment of inertia of water plane area in damaged compartments, is more or less constant at all heights, and hence the loss of G.M. may be considerable in the early stages, and less important as the water rises in the compartment and so raises the position of the center of buoyancy of ship. For this reason it is more important to have watertight doors low down in the containing bulkheads of damaged compartment shut at the time of the casualty than similar doors at a higher level. The final result may be the same, but by confining the longitudinal extent of the free water low down, the ship may continue upright, and if the ship has ultimately to be abandoned, the upright position will facilitate the getting away of the boats and so conduce to the saving of life.

Out of the total number of cases examined, only some six or seven were stated to have capsized, although these included some important vessels, and of these, one was attacked by torpedoes, shells and bombs, while another was hit by two torpedoes. A fairly large number of ships are said to have retained a list, either "slight" or "heavy," after damage, most of these being in a "light" or lightly laden condition. In the large majority of cases, however, there is no hint of permanent list, and the vessels regained the upright after damage. As to the possibility of listing in the "light" condition, it will be remembered that many vessels of relatively fine form have very moderate metacentric heights in that condition, so that the loss of stability due to the inflow of water, mentioned above, might well suffice to give a negative G.M. with consequent heeling; in one case, indeed, the loss of stability due to this cause was so great as to result in the capsizing of the vessel. On the other hand, vessels of full form, carrying their breadth well down, often have very large metacentric heights when light, and many such vessels in this condition have continued to float upright with two or more large compartments flooded.

Generally, of course, after damage the mean draft of a vessel is considerably increased, but in the case of laden oil carriers the vessels remain at about the same draft as before, if struck in way of the tanks. In such vessels the machinery space is usually aft, and if the engines and boilers are in one compartment, a laden vessel is likely to sink if struck aft. This points to the desirability of fitting a watertight bulkhead between engines and boilers in these otherwise well-subdivided vessels.

CONCLUSIONS

A consideration of nineteen cases cited in the paper, and of the many others analyzed, prompts the following conclusions and observations:

1. Many ships after damage remained afloat and reached port, so it is clear that in these cases the watertight subdivision was sufficient under the actual conditions as to lading.

2. Remembering the considerable longitudinal extent of the damage from mine or torpedo, the damage from such causes to a small ship is more likely to be fatal, on the average, than that resulting from collision; whereas for large ships, capable of floating with two adjacent compartments opened to the sea, the maximum direct damage from mine or torpedo represents the maximum effect likely to be caused by a collision blow in the region of a bulkhead, and such vessels should survive. Some of the large vessels which were sunk were not so well subdivided as recommended by the recent Bulkhead Committee. Had they been so divided, and had doors and sidelights been closed, such vessels would have continued afloat.

3. It is clear, from the cases cited, that many large vessels did not survive damage from a single mine or torpedo, and the reasons for this, acting singly or in combination, were:

(*a*) Watertight doors were open, which were not, or could not be, closed after the casualty, thus giving water access to compartments not directly affected by the explosion.

Among the causes likely to prevent or render inoperative the closing of doors after the casualty may be mentioned: distortion of bulkheads caused by explosion; sudden inrush of water through the doorway, coupled with delay in closing from above; presence of coal or debris washed into the doorway; and, probably, distortion of bulkhead due to water pressure on one side.

ORDINARY MARINE CASUALTIES

In determining what bearing these facts may have on ordinary marine casualties, it is necessary to consider whether such casualties are likely to occur so suddenly or unexpectedly as under war conditions. It might be presumed that during a fog, or when a collision seems imminent, all watertight doors would be closed and other precautions taken to minimize risk. On the other hand, it is proverbially the unexpected that happens, and many cases might be cited where ships have received ordinary marine damage with watertight doors open. In such cases doors constitute a distinct source of danger, the causes tending to make them inoperative being similar to those mentioned above. The Bulkhead Committee recognized the possible danger of open doors and recommended that the number of openings in bulkheads should be reduced to the minimum compatible with the design and proper working of the ship; they also suggested regulations for assuring that the doors should be kept in thorough working order. The possibility of dispensing entirely with watertight doors on main transverse bulkheads was thoroughly discussed by the committee, and the possible dangers involved in doing so were considered, but in the light of subsequent experience the matter appears to deserve reconsideration, particularly as open doors may lead to the vessel listing considerably, thus making it difficult to get boats away. It would seem possible to dispense with such doors in the machinery compartments of large transatlantic liners designed to operate continually between particular ports, and in large passenger and excursion steamers engaged on relatively short runs. If in certain cases it seems particularly inconvenient from considerations of easy communication to dispense with doors altogether, it would still be desirable from the point of view of safety to fit the doors high up rather than low down in the holds. In particular, it would seem that the doors leading to shaft tunnels, where there is a minimum of traffic, could generally be done away with, access to the tunnel being gained through a watertight trunk abaft the after engine room bulkhead, as recommended by the committee of this Institution and as actually carried out in many vessels. It may be added, in passing, that the difficult problem of bunker doors would be solved in cases where oil fuel could be adopted.

(*b*) Below the bulkhead deck sidelights were left open.

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and these became immersed under the influence of sinkage and heel, combined in some cases with the effect of trim, thus admitting water to intact compartments.

In a large vessel there may be several hundred sidelights below the bulkhead deck, a considerable proportion of which are capable of being opened. Recent experience goes to show that with the usual organization on board ship it is most difficult to ensure that all sidelights are effectively closed, even when stringent orders have been issued to this effect.

(c) Suction pipes were often fractured in damaged compartments, thus putting other spaces in communication with the sea. Early experience in this respect led to a recommendation by the Board of Trade that an efficient non-return valve should be fitted at the ends of such pipes, while this Institution advised, on the same subject, that a screw-down non-return or similar valve should be fitted, to be worked from the bulkhead deck. This recommendation has been generally acted upon.

(d) Bulkheads and tunnels were found to be leaky through defective calking, through bolt and other holes left in the plating, and through faulty fastenings.

The complete carrying out of the Bulkhead Committee's recommendations as to inspection and hose testing of bulkheads and tunnels, and careful inspection during periodical surveys should ensure the discovery and lead to the remedy of defects such as those under consideration.

(e) Pipes such as voice pipes and pump suctions from hotwell were carried through bulkheads low down in holds, without valves at the bulkheads.

(f) Air escape pipes and test pipes were sometimes carried a short distance only above the tank top, some with and others without stop cocks or screw caps at their upper ends. At the time of casualty stop cocks have been found open and the screw caps provided have been found not in position, so that water obtained access to empty spaces. The recommendation of the Bulkhead Committee that air pipes should extend at least as high as the bulkhead deck thus appears to be a reasonable one, while it seems desirable that sounding pipes should be treated similarly.

STRUCTURAL STRENGTH OF BULKHEADS

4. Referring next to the subject of the structural strength of bulkheads, it was found in the great majority of ships which came into port after being damaged that the bulkheads bounding damaged compartments had stood the water pressure quite satisfactorily, and some of these were fully tested. In the cases of two or three vessels which foundered it was stated that bulkheads gave way, but in one of these the explosion occurred close to the bulkhead, which was probably strained thereby, and this would be aggravated by the severe stresses set up by the heavy weather experienced, while in another the leakage past a bulkhead occurred when the ship was in light condition, so that no question of structural strength appears to arise here. Reviewing all the evidence, therefore, it is submitted that nothing has occurred which throws doubt upon the adequacy of the scantlings for bulkheads recommended by the Bulkhead Committee. It will be remembered that that committee made tests on actual bulkheads, and, as a result, adopted scantlings somewhat in excess of previous practice, with more efficient end connections; and war experience warrants the conclusion that the scantlings so determined are sufficient for their purpose, with a reasonable margin of safety.

5. War experience has drawn renewed attention to the question of stability in vessels subdivided transversely. Previous experience and investigation had led to the conclusion that vessels damaged within their power of flotation would in general remain upright or without serious list, and this has been fully justified by many recent examples. Moreover, some vessels which capsized, and others which took a dangerous list, did so in consequence of compartments being flooded other than those necessarily opened to the sea. It is clear, therefore, that if the integrity of all bulkheads except those actually damaged by collision or explosion could be assured, the possibility of dangerous heeling developing would be reduced to a minimum.

LISTING OF VESSEL AFTER DAMAGE

The liability of a vessel to list after stated damage depends upon the metacentric height at the time. If this is reduced to a small value to obtain maximum steadiness at sea, it is very probable that heeling will develop in the early stages of flooding, although it may diminish or disappear as the water within the vessel rises. In such cases no ill effects will be experienced unless it immerses open side ports, or the bulkhead deck if the injury extends above that deck; but if the damage is so great as to cause ultimate foundering, any serious permanent list would interfere with the getting away of the boats.

The metacentric height actually given to a vessel is determined by several considerations. For steadiness at sea, this height should be small; to avoid undue heeling under the influence of wind pressure, particularly in high-sided vessels, it should be moderate in amount, while a third consideration is that just mentioned, viz., that after considerable damage dangerous heeling should not result. If it could be assumed that all ports below the bulkhead deck would be closed at the time of the casualty, a reasonable standard for determining the requisite metacentric height in large passenger vessels would appear to be that it should be at least sufficient to prevent such serious permanent list as would prevent the getting away of the boats when a length of ship equal to the floodable length amidships was opened to the sea.

Reviewing, therefore, the experience gained under war conditions, it will be seen that, while it has shown that arrangements designed to minimize risk have not, for various reasons, been fully effective and that there may be possibilities of improvement in some details, the results, given the conditions actually existing, were such as might have been anticipated from previous knowledge.

Cylinder Oil Requirements*

Because of the method usually employed, and the very small quantity used, a cylinder oil that would not reach the parts or an ordinary oil that would carbonize, or one that would fail to maintain an oil film between rubbing surfaces under the conditions of operation, would not furnish lubrication.

A cylinder oil is demanded which will minimize friction and wear in the engine, at the scant feed, whereby oil troubles in the boilers are eliminated.

The specific requirements of a cylinder oil for the lubrication of valves, cylinders, valve and piston rods are:

(1) The ability to spread readily over rubbing surfaces.

(2) The ability to maintain an oil film under high pressure (high temperature) steam conditions.

(3) The ability to resist the washing effect of water of condensation in the cylinders.

(4) The quality to furnish lubrication at small feed.

(5) The quality to lubricate without sticking the piston rings and the stuffing box packing rings.

(6) The quality to separate quickly from condensed steam, avoiding oil troubles in boilers.

*From *The Compass*, published by Vacuum Oil Company, New York.

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Notes on Shipbuilding and Shipping

BY "OLD SCOTCH"

Shipbuilding is looking upwards again, as the world conditions are making towards an even keel. The latest survey of the entire shipbuilding advancement in the great maritime nations discloses the fact that in spite of the thousands of new ships turned out in the feverish haste of war times, we are still not up to the normal supply with which to carry on sea traffic.

THE insatiable demands for petroleum and its products are largely responsible for another impetus to shipbuilding, both in this country and abroad. A productive capacity of over 1,000,000 barrels a day throughout the world, with a demand in excess of production, means that many more tankers than those in being and under construction must be built to meet the requirements. Every day of late there are rumors of orders for new tankers being placed in American yards. The definite contracting for six new tankers for British account in Pacific coast yards within the past fortnight shows quite conclusively that this country can compete for this particular type of ship with foreign builders. It also shows that the battle royal is on to secure control of the world's oil supply, which all must admit is rapidly dwindling and becoming a matter for most careful consideration.

Dwindling Oil Supply Makes Economy Imperative

The excess of demand over supply of this favored type of fuel brings more acutely, every day that passes, the fact that we must economize in the use of oil for marine propulsion by using internal combustion engines. If the writer can read the signs of the times correctly, we are on the eve of a great construction of motorships in this country. We are sadly behind our European rivals, but it is not too late to get into this new field, and we can profit by the experimenting of our rivals. Several of our large shipyards have been sending representatives on hasty trips to Europe to learn of the latest developments in this type of engines, and, if possible, to secure the American rights for manufacturing the most successful types here. Shipowners are becoming alarmed at the quickly mounting cost and great scarcity of oil, and are seriously considering new construction to cut down their fuel costs and delays in the delivery of cargoes.

Tax Exemptions Give Impetus to Shipbuilding

Section 23 of the Jones law, granting tax exemptions to shipowners who invest their surplus earnings in the construction of new ships in American yards, has given a great impetus to shipbuilding. Plans have already been approved by the Shipping Board for at least thirty ships to be constructed under this provision, and many more are to follow. The Board has required that such ships be classified by the American Bureau of Shipping, and it is more than possible that the owners of such exempted ships will be required to keep them insured in American companies, so long as the rates do not exceed the world rates for this kind of insurance. The object of this Governmental aid is to help build up the merchant marine in all its branches. One-third the value of a modern ship at going rates is the limit of exemption of taxes, and it must be admitted that it will be a great help to shipowners. The interest on the capital cost and depreciation of that amount of exemption will more than pay the entire crew costs of a 12,000-ton ship. This will insure success in competition with the vessels of any nation.

Another fertile source for increase in shipbuilding is Section 11 of the Merchant Marine Act, which provides what is known as the Construction Loan Fund. By the authority of this section the Shipping Board is empowered to loan $25,000,000 a year for a period of five years to American citizens who will build new tonnage in American yards. As the Board can loan up to two-thrids of the cost of a new ship, this can result in a sum of $37,500,000 being invested in new shipbuilding each year. Approximately at current rates this should result in the building of twenty 10,000 deadweight ton ships in each of the next five years, or an equivalent amount of tonnage of other sizes. As this money loaned can probably be obtained from the Government at a less rate of interest than from private sources, this proposition should prove to be very attractive to prospective shipowners. It is required among other restrictions that vessels constructed under this agreement shall be of the "best and most efficient type." This should imply that a number of Diesel-engined ships may be constructed by means of this method of Governmental aid.

The Ladies Come Aboard

The order of the Shipping Board permitting wives to accompany captains of some of the Board ships has been provocative of considerable discussion. Of course to persons familiar with shipping this is not a new proposition at all. As a matter of fact it has been somewhat of an established custom for many years. At one time captains of warships were granted that privilege under special circumstances. It can readily be seen that much discontent might be engendered among the officers of any ship on which the captain's wife was allowed to live. The logical argument would be that, if the captain's wife can sail the seas, why not let the first mate and the chief engineer take along their better halves; and then, if they are given the privilege, why not have all the officers thus favored. It might then be broadened so that any married man in the crew could take his wife along. Probably this latter concession would not add many, if we believe in the oft-repeated adage that a sailor has a wife in every port. There would, for them, be no need of this "carrying coals to Newcastle," and much hair pulling on the wharves might be saved.

This wife-carrying order coming so closely after the ratification of the suffrage amendment may possibly be a harbinger of equal rights for women on the seas, and who knows but that before many months every Yankee merchant vessel may have in its crew lists some attractive blondes and brunettes shipped for the round trip. May I not suggest that this is possibly the solution of that very important problem of how to induce American young men to follow the sea?

Americanizing Our Crews

This problem, by the way, shows great encouragement as things now exist, for Admiral Benson has recently announced officially that of the crews (not including licensed officers) of all the ships operated by the Shipping Board.

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which form the greater part of the American merchant marine, fully 57 percent are now American citizens, as compared with about 10 percent in the year 1914. This speaks volumes for the efforts of the Shipping Board in Americanizing our crews. The high wages naturally attract many young Americans, and added to that many of the new recruits have had their interest in shipping aroused by serving in the Navy or shipyards during the war.

All this is very encouraging to our efforts in operating a merchant marine, and there seems to be no good reason why we should not in a year or so further increase the percentage of American citizens who will follow the sea for a livelihood. It has been said that young men in this country do not take kindly to the sea, as the bulk of our population live inland and are consequently not familiar with seafaring matters. Heredity, however, has a strong tendency to influence our habits and customs, and somewhere back in the lineage of thousands of our citizens now living remote from the coast will be found ancestors who were fishermen or seafarers in European countries, and hence the call of the sea seems to be reaping its rewards from the young men reared in farming communities.

YOUNG MEN AMBITIOUS TO BECOME OFFICERS

With true American instinct it is undoubtedly the fact that nearly all of these youngsters expect to become licensed officers as quickly as possible. Such a laudable ambition is bound to result in a very high class of officers at no distant time, when normal conditions gain the ascendancy. As an earnest of this tendency one of the great New York dailies published an interview with a prominent member of one of the marine engineers' associations, in which he bemoaned the fact that the efforts of the American engineers to have the requirements of the examinations for licenses increased had not met with much success, the blame being put largely on the shipowners themselves. This seems to be a very illogical situation, if such is the fact. Shipowners, more than any others, must realize that our success on the seas depends more on highly efficient engineers than on any other class of seafarers. With the tremendous costs of fuel and machinery repairs which now exist, the best way to circumvent them is to increase the efficiency of the engineering personnel. Carelessness or lack of efficiency of the engineer on watch oftimes results in waste of fuel and oil or in damaged conditions of machinery, necessitating very expensive repairs.

STANDARDS FOR LICENSED ENGINEERS SHOULD BE RAISED

By all means raise our standards for licensed engineers in this country, and while we are about it let us have uniform requirements in every port, so that the examinations will not be conducted solely as dictated by the local inspectors. The officers of the inspection service as well as the engineers themselves all seem to be in practical agreement on this subject, so it seems to be up to Congress in the forthcoming revision of our navigation and steamboat inspection laws to bring this highly desirable state of affairs about. The engineer officers in our merchant service, as well as in the old Navy, have too long been treated as a necessary evil, and to have an efficient merchant marine they should be given every consideration in pay and comforts that are given deck officers, and then some.

Seagoing conditions in the last half century have radically changed; the sailing vessel has now nearly disappeared from the seas, and with them should go all discriminations in favor of sailing masters, and to the detriment of the new type of responsible men, the engineers. According to the latest reliable statistics, the proportion of sailing vessels in the world's tonnage is now under 6 percent, as compared with 8 percent in 1914 and 32 percent as recently as 1902. Truly this is the age of steam and motors, and the engineer should have his full due.

Oil Burning Installation of the Aquitania

Conversion of Fuel System Results in Increased Speed—General Details of Oil Storage—Pumping Arrangements—Structural Changes

THE Cunard liner *Aquitania*, which during her eight months' retirement from the transatlantic service was converted into an oil burner, is the first of the Cunard fleet to be so equipped. The work of refitting her coal bunkers, installing oil burners and the reconditioning in general was carried out by Sir W. G. Armstrong Whitworth & Company, Ltd., at the Walker yard, Newcastle-on-Tyne.

The success of the first voyage after reconditioning, on which the *Aquitania* averaged 23.10 knots from Liverpool to New York, two days' run being made at a speed of 24 knots, fully justified the expenditure that had been necessary for the work. On her return trip to England she maintained an average of 23.45 knots, reaching a maximum of 27.40 knots on a run of 129 miles in three hours. Her original contract speed as a coal burner was 23.5 knots.

ADVANTAGE OF OIL BURNING INSTALLATION

The advantage most often sought in converting a ship from coal to oil fuel is the increase in cargo space made available by eliminating the coal bunkers and utilizing the double bottom for oil storage. Since the *Aquitania*, however, is not essentially a cargo carrier, and as no particular advantage could be obtained by using the double bottom tanks for storing oil, the coal bunkers of the vessel were reconstructed for fuel storage.

It may be assumed therefore that the principal advantage obtained from the use of oil as fuel in this vessel is the increased speed with the attendant economies in the boiler room. These economies are too well known to need review at this point, the single fact being pointed out that with the 168 furnaces in the *Aquitania* equipped to burn coal, assuming that 28 fires were cleaned every watch, approximately 8,000 horsepower was lost from her cruising power. The constant heat maintained by the burners in oil-fired boilers eliminates this waste, which probably accounts for the increase in speed that has been recorded.

ARRANGEMENT OF BUNKERS

In this ship, with a beam of 97 feet, with three large double-ended boilers arranged abreast, there remains a space of about 18 feet amidships, gradually reducing to 6 feet at the forward end of the boiler space, which formed a coal bunker on each side, and in this space, extending the full length of the boiler space, a matter of 369 feet, the oil is now carried. These side tanks do not form a continuous

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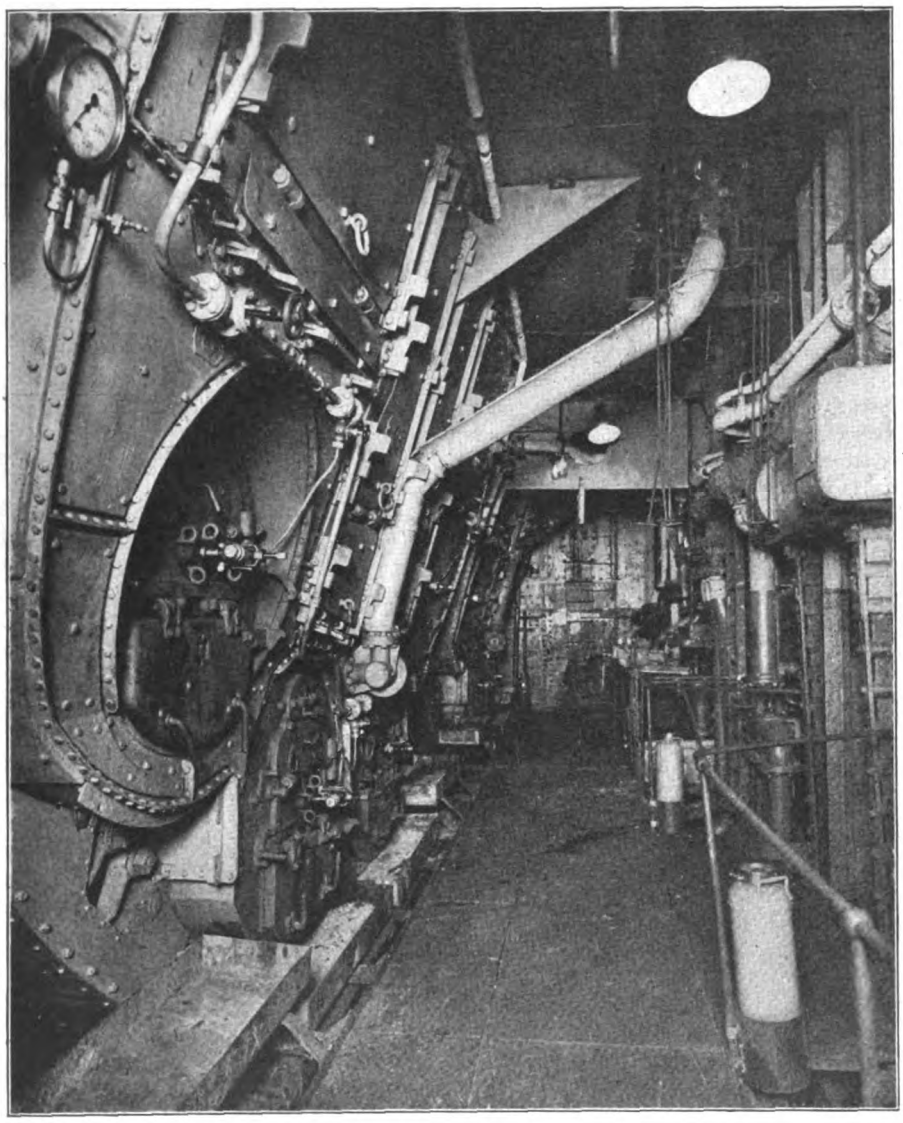

General View of Single Boiler Room Showing After End of Boilers, Fuel Oil Injectors, etc.

group on each side, but are broken into two groups, port and starboard, by Frahm's anti-rolling tanks, which take up 32 feet of the length. In addition to these side bunkers, large athwartship bunkers, arranged forward of No. 1 boiler room, between Nos. 1 and 2, and between Nos. 2 and 3, have also been made suitable for oil carrying.

The large storage capacity in these side tanks and cross bunker tanks, however, did not prove sufficient to enable the ship to perform the double trip without requiring replenishing, so that six of the double bottom tanks have been made suitable for oil, to enable the 7,600 tons of oil required to be shipped at New York. Of the total quantity, 5,200 tons will be carried in the fore and aft side bunkers, 1,900 tons in the athwartship cross bunkers, and 700 tons in the double-bottom tanks. All the storage tanks, including the six double-bottom tanks, will be used solely for oil, no water ballast connections being provided. These connections are usual where double-bottom tanks are intended for oil, and involve many complications.

Reconstructing Bunkers

To make the coal bunkers suitable for carrying oil, a large amount of structural steel work has been necessary. For instance, all the bunker bulkheads have been specially stiffened, so that deformation will not occur with the weight of oil pressing against them.

All the plate joints have been specially treated, the general practice adopted being to fit stout double-riveted joggled plate straps over each plate landing, making a thoroughly oil-tight joint. Special attention has been given to plating and riveting of all steam pipe trunks and passages where these penetrate the cross bunkers. Transverse wash bulkheads have been fitted in all the side bunkers, and suitable wash bulkheads have also been constructed in the cross bunker tanks. For the full length of the side bunkers, and also round the cross bunkers, gutterways have been constructed to catch any oil which may find its way outside the tanks through leaky joints. In communication with these gutterways are bilge wells in each boiler room from which the oil bilge well pumps draw.

In the cross bunker storage tanks forward of boiler rooms Nos. 1, 2 and 3, four settling tanks have been constructed, each tank being of 60 tons capacity. In No. 4 boiler room two settling tanks of similar capacity each have been incorporated in the side bunkers, one port and one starboard. In this ship there are four boiler rooms, the three forward ones each containing six double-ended boilers, and the after one three double-ended boilers. Two settling tanks, it will be noted, are provided for each group of three boilers.

In certain parts of the boiler rooms the side bunkers overhang the wing boilers, and to ensure that there will be no chance of oil dripping on the hot boiler tops, special screen plates have been fitted in way of these overhanging parts, so that any oil which may leak through will be directed to the oil gutter below.

In addition to the special riveting which has been adopted to ensure oil-tight joints on all the tanks, electric welding has also been largely employed, with the result that a thoroughly sound and substantial tank construction has been made. The oil fuel will be burned under the White low pressure mechanical system, which has proved efficient and reliable on existing oil burning vessels.

Pumping the Oil

The pumping and heating plant has been supplied by Messrs. Brigham & Cowan, South Shields, and a complete installation in duplicate has been provided for each group of three boilers. In the large boiler rooms each containing six boilers there are four sets of pumping and heating plants, while in the small boiler rooms there are two sets. This ensures that only under very exceptional circumstances will the supply of fuel to the burners be interfered with through any fault of the pumping plant. The pumping and filling arrangement throughout the ship has been prepared on a substantial scale with a view to ensuring the satisfactory operation of the ship under all cir-

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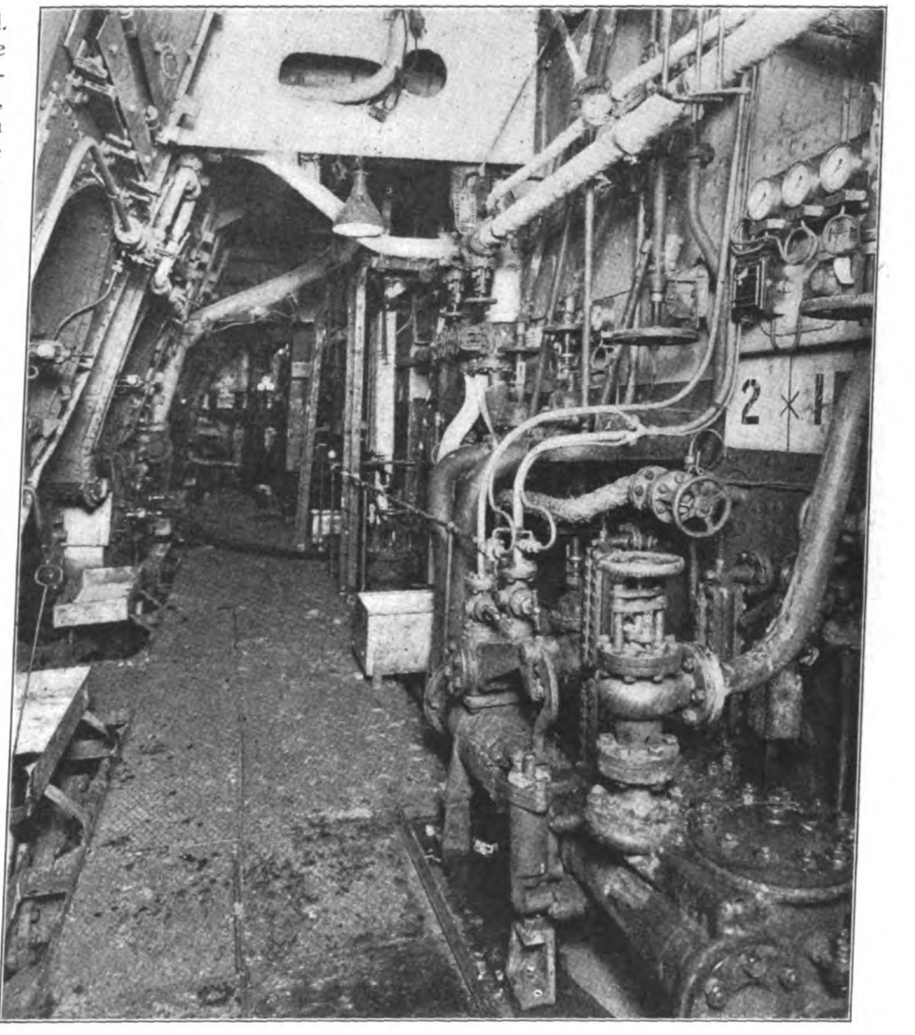
cumstances that can be expected.

For the full length of the boiler rooms two suction and filling mains, 8-inch bore, are fitted, one port and one starboard. In each boiler room these mains are cross-connected, and in addition suitable shut-off valves are provided, so that the system in one boiler room can be entirely isolated from any other boiler room.

SPEED OF BUNKERING THE AQUITANIA

Special attention has been given to the bunkering arrangements, so as to ensure that the minimum of time will be required to bunker the vessel. Each boiler room is provided with two 8-inch filling pipes from the working deck, one port and one starboard. These pipes communicate with the suction mains already referred to. Special filling compartments have been arranged on "E" deck, where the connections for coupling to the tank steamer or shore hose are fitted. These compartments are entirely separate from any adjoining accommodation, so that should any oil escape from the save-all trays which are fitted under the valves and strainers the oil will not be free to spread over the deck.

On each side of the ship there are four connections for bunkering purposes. Should the connections on one side of the ship be in use at one time it would be possible completely to bunker the vessel in about six hours. From this it will be seen that the time required in port for changing over is not likely to be determined by the fueling arrangements.



General View of After End of No. 4 Boiler Room

STORAGE TANKS

Precautions have been taken to eliminate the possibility of overfilling the tanks. A special arrangement of air and overflow pipes has been installed by means of which should any tank be inadvertently overfilled the oil will overflow into one of the storage tanks specially arranged for this purpose. An overflow storage tank is provided in each group of tanks in each boiler room, port and starboard. With the arrangement of overflow pipes and tanks, a sequence of tank filling must be adhered to. These overflow connections, however, are only fitted as safeguards should the other means provided for ascertaining the quantity of oil in the tanks fail.

Each storage tank is provided with a Pneumercator gage, as supplied by Messrs. Kelvin, Bottomley & Baird, Glasgow. By means of these gages the depth of oil and quantity of oil in the tanks can be noted at any time. It is usual to fill the tanks to 95 percent of their capacity, and this quantity is indicated on each Pneumercator gage. In addition to these gages, electric float alarms are fitted, so that when the 95 percent capacity level is reached a bell rings. No sounding pipes are fitted in any of the oil tanks.

To ensure that the oil will run freely from the tanks in cold weather, or when heavy oil is being used, heating coils are fitted in all the side bunker tanks and in the double-bottom tanks, but not in the cross bunker tanks, where the heating of the adjacent boiler rooms renders heating coils unnecessary.

SETTLING TANKS

From the storage tanks the oil is pumped by large vertical direct acting pumps of Weirs' make to the settling tanks. Two of these transfer pumps are fitted in each boiler room, those in No. 4 boiler room being of 70 tons per hour capacity each, and those in the other boiler rooms of 100 tons per hour capacity each. The capacity of each settling tank is such as to ensure sixteen hours' supply for three double-ended boilers, so that about fifteen hours will be allowed for the settling of the oil in one tank while the other tank is in use.

SUPPLYING OIL TO THE BOILERS

To facilitate separation of water from the oil, heating coils are fitted in these tanks. Pneumercator gages and electric float alarms are also fitted to the settling tanks. The removal of the settled water from the tanks is done by the transfer pumps, which have special connections for this purpose, so arranged that it will not be possible for the pumps to draw oil from the settling tanks and discharge it overboard.

From the settling tanks the oil pressure pumps take their

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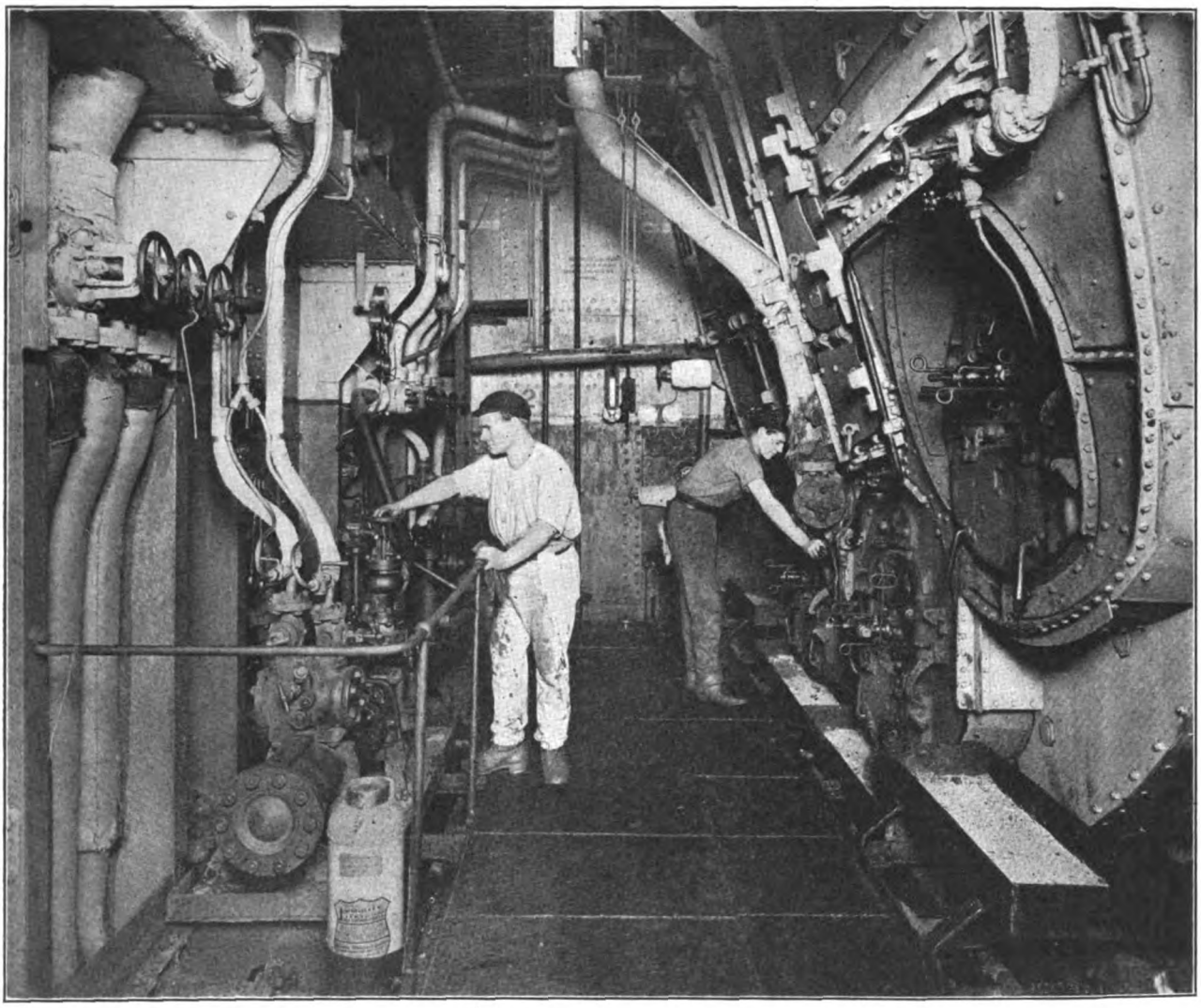


Single Boiler Room, Showing Oil Fuel Unit and Furnace Fronts on Cunard Liner *Aquitania*

supply through suction strainers, discharging through the heaters and discharge filters to the burners in the furnaces. A ring main is fitted in each boiler room to which each pumping unit is connected. An emergency connection is also made to this ring main so that the pressure pumps can draw direct from the oil storage tanks. Special attention has been given to the fire extinguishing arrangement in the boiler room. With a view to speedy detection of oil on the double-bottom tank tops, a special skeleton arrangement of stokehold flooring has been fitted.

Broad working gangways have been fitted in front of the furnaces, but these gangways are kept well clear of the bulkheads, leaving an open space to view the tank top and oil gutters. No wood has been used in the construction of the flooring. The installation of the boilers has been increased, with a view to keeping the boiler temperature as low as possible.

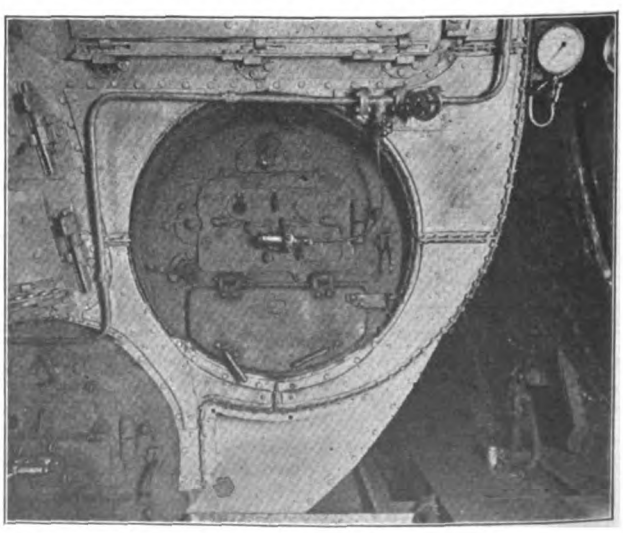
New Electric Wiring

The electric wiring of the boiler rooms has been rearranged to suit the altered conditions. The ventilation of each boiler room, auxiliary machinery room, passage, fan flat, tank tops, etc., has been very thoroughly considered. Additional ventilating fans and trunks have been fitted. For raising steam from cold boilers, a motor-driven pump is fitted in one boiler room.

Special gas exhausting nozzles and pipes with connections to the oil suction mains have been fitted to remove dangerous gases from the storage tanks before these are entered for inspection.

Reconditioning and Refitting Work

In addition to the conversion of her machinery the ship



View of Furnace Front as Fitted With Oil Fuel Arrangement

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has been entirely renovated and refitted. New carpets have been provided throughout the cabins and saloons and new rubber tiling for all passageways. The furniture, however, is in most cases the same as that carried by the ship on her first voyage in 1914. The furnishings have been stored in the company's warehouses since that time and have in no way deteriorated; in fact, it would be impossible to replace them at the present time.

Among the improvements that have been effected, a bank and information bureau have been installed in the reception room opposite the restaurant on "D" deck. To the swimming tanks and gymnasium have been added a sunbath room. The staterooms on the boat deck have been converted into one-berth rooms, each fitted with a bed and settee, and the whole of "C" deck amidships has been entirely rebuilt. The staterooms have been enlarged, this result being obtained by reducing the original accommodations to thirty-two rooms. Many of the staterooms now have private dressing rooms.

Panama Canal Shops Rebuilding the Steamship Marne

THE 9,600-ton steamer *Marne*, which was sunk by submarine fire in the harbor of Cristobal, at the Atlantic entrance of the Canal, on January 24 in order to extinguish a fire in her cargo of oil and gasoline, has been raised and discharged and is being rebuilt at the Balboa Shops of The Panama Canal.

The use of the submarines to sink her was resorted to because of the intense heat aboard, which made it impossible to open the seacocks. After the fire had been extinguished and the ship raised, a second fire broke out, with a violent explosion, while she was being discharged at dock. It was necessary to beach her again in order to put out the second fire.

The submarine shots, double scuttling and explosions naturally made necessary a considerable amount of repairs. These are being directed toward restoring the *Marne* to the condition in which she was prior to the first fire. Figs. 1 and 2 show how the vessel has been stripped down in the process of reconstruction.

The engines and auxiliary machinery have been taken out and are being overhauled. The deck structure amidships has been entirely removed, and a great deal of the material is being salvaged for replacement. Fig. 1 shows very distinctly the holes made by the submarine shots in her stern. Fig. 2 was taken from the forecastle, looking aft, and shows how thoroughly the upper part of the ship has been stripped. The engines had been lifted out by the 50-ton wharf crane at the time this photograph was taken.

Fig. 1.—Stern of Steamship *Marne*, Showing Effects of Submarine Shots

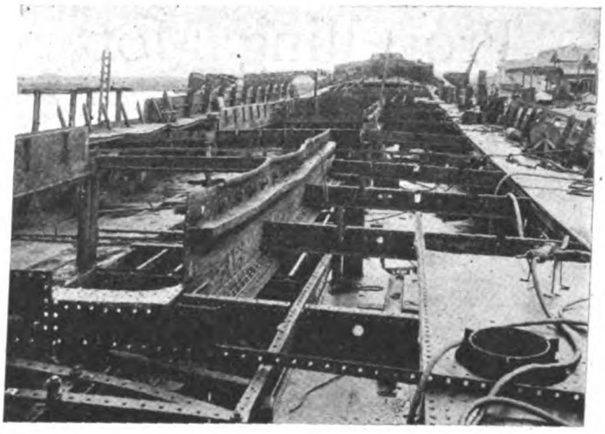

Fig. 2.—Steamship *Marne*, Showing Damaged Plates and Beams

Fruit Steamers Hibueras and Nicarao

(*Concluded from page 803.*)

One 12-inch diameter ventilator to galley.
One 8-inch diameter mushroom ventilator to all passenger and officers' staterooms.
Two 24-inch diameter ventilators to fireroom.
Four 20-inch diameter ventilators to engine room.

LIFEBOAT EQUIPMENT

The steamers carry on the boat deck two metallic lifeboats, 26 feet by 8 feet 2 inches by 3 feet 4 inches, with a capacity of 420 cubic feet, or 42 persons each. These lifeboats are operated with Welin patent davits and Raymond releasing hooks.

On the top of after house there is stowed a wood workboat, round bottom, 16 feet by 5 feet by 2 feet, suspended on round swan neck davits; and a captain's gig, also of wood and round bottom, 18 feet by 5 feet 6 inches by 2 feet 4 inches and suspended on round swan neck davits.

STEERING GEARS

A steam steering engine of the Hastie type, 6 inches by 6 inches, with extended barrel, is located on the shelter deck inside of the after end of the midship house.

An auxiliary screw hand steering gear is fitted directly over the rudder stock on the shelter deck, the steering wheel being 6 feet in diameter.

CAPSTAN AND WINDLASS

A steam capstan of Hyde design, with warping drum, is located on the stern for warping the steamer. The capstan has a 6-inch by 6-inch engine, with a large gypsy head of 16 inches diameter.

A steam brake windlass is fitted forward, with wildcats suitable for 1 9/16-inch stud link chain cable.

A complete heating system has been installed embracing all living quarters. All the steam heating apparatus and plumbing fixtures are modern and thoroughly up-to-date.

The dock trials and trial trips of the *Hibueras* and *Nicarao* were conducted to the entire satisfaction of the owners and their agents, William Gardner & Company, of New York, and the results of all tests were very gratifying to the builders. The steamers were constructed to burn either coal or oil, the *Hibueras* having left the yard burning coal, while the *Nicarao* sailed with oil as fuel. Immediately upon their acceptance by the Cuyamel Fruit Company, these vessels were placed in the Honduran fruit trade.

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Propelling Motors For Electric Drive

Types of Motors Developed by the General Electric Company for the Propulsion of Warships and Cargo Vessels

THE induction motors which the General Electric Company have developed for ship propulsion may, for the sake of convenience, be roughly divided into two classes—those designed for battleship propulsion and those for cargo boats. The reason for making this distinction is not only because of the respective sizes, but also on account of various differences in the electrical construction and operation.

The Jupiter's Equipment

The first large electrically propelled ship was the collier *Jupiter,* which was equipped with an induction motor of the phase wound rotor type, the motor being started and reversed through an externally controlled water rheostat. The performance requirements of motors that would be adaptable to battleship drive caused necessary developments and improvements over this comparatively simple type which proved highly successful for the class of work it was called upon to perform.

The two main requirements were high speed with full power and a medium speed for a maximum cruising radius. Very quick reversal power was also required, and this at full speed.

Changeable Pole Motor Developed

The result was that a changeable pole motor was developed, those on the *New Mexico, California* and the other ships having a pole changing ratio 3 to 2, taking power at full speed from both generators and at low speed from one. The winding of these motors, which are quarter phase, has the coils so grouped that a change at the terminals will give a balanced distribution for either 24 or 36 poles. Since the four motors receive power from two generators at full speed, and one generator at cruising speed, the best combined operation is with decreased voltage on the 36 pole operation.

The rotor also has some special features, designed to meet the requirements as shown by the operation of the *Jupiter.* These trials showed that the starting resistance would only be required for a very short space of time, during starting and also during reversing, to exert a maximum torque on the screw and bring it up to speed rapidly.

Battleship Motors

For this purpose the rotor of the *New Mexico* motors is built with two squirrel-cage windings, the outer, high starting rheostat, on starting and reversing, while the inner, low resistance winding, is what the motor runs on when it is up to speed. By this construction the torque advantage of the high resistance rotor is obtained with the low speed and high efficiency of the low resistance winding when the motor is up to speed.

The motors for the *California, Maryland* and *West Virginia* are different in that high resistance winding is at the bottom of the slots, while on top is the phase winding. The latter is connected to slip rings, which, when shorted, puts the two windings in parallel. When the rings are open circuited, all the current flows in the high resistance winding. On these battleships the rings are shorted by contactors mounted on the end shield of the motor, the contactors being operated from the control board.

Minimum weight was assured by the use of steel throughout in the mechanical structure. The stator frame

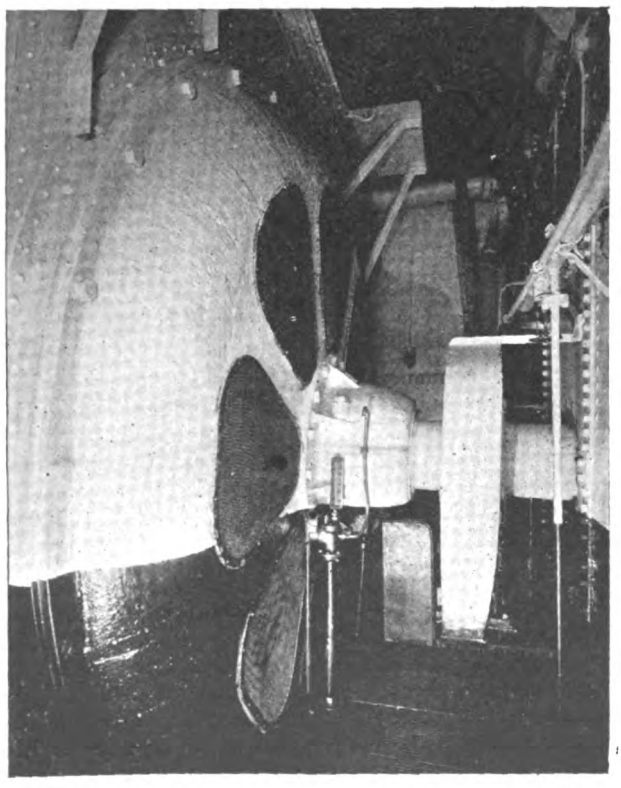

Fig. 1.—Propelling Motor, Showing Direct Connection to Propeller Shaft, U. S. S. *New Mexico*

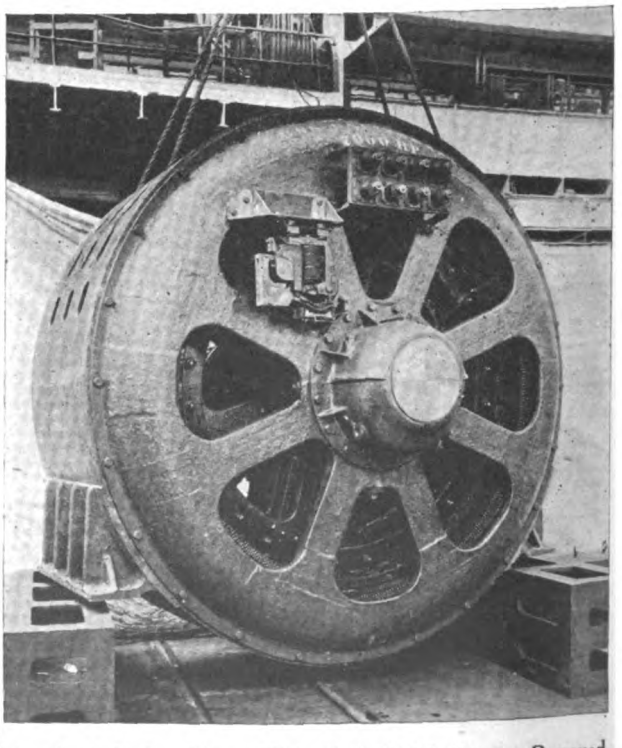

Fig. 2.—Induction Motor With End Shield Screens Removed. (Coupling End)

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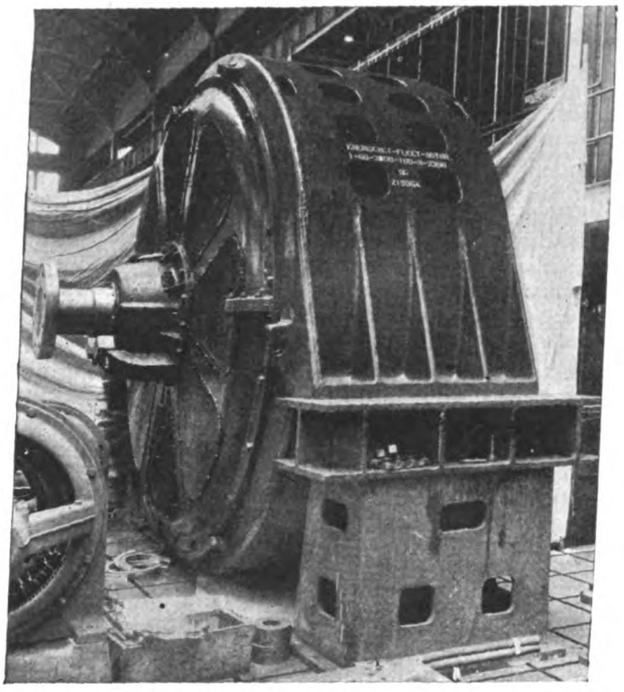

Fig. 3.—Induction Motor for Cargo Boat Drive. (Coupling End)

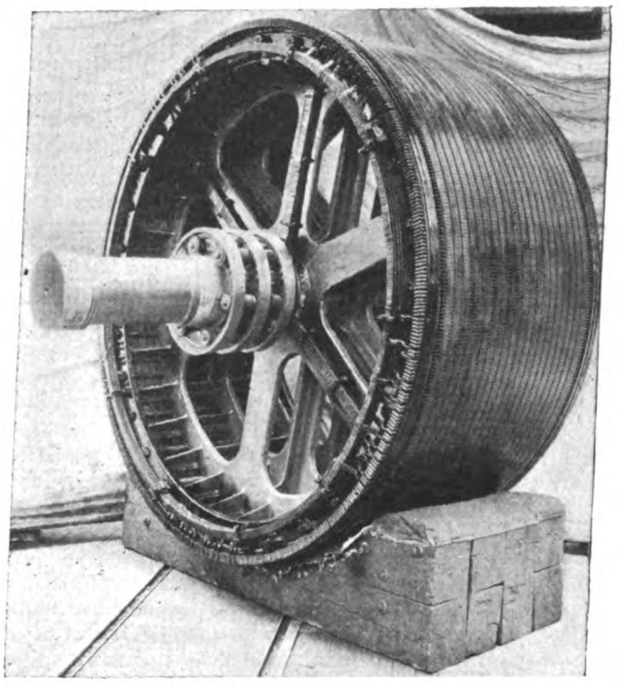

Fig. 4.—Induction Motor for Cargo Boat Drive. (Rotor-Collector End)

is made of a series of circular rings of L-beam section, each one having enough strength to support its section of punchings. Boiler plate extending the full length of the frame was rolled to fit these beams and was securely riveted to them, which gives a very rigid and compact structure. Holes for ventilation were then cut into the top of the plate. The construction of the rotor was carried out so as to have the same mechanical strength as the stator. All coils were insulated with mica and given treatment with a special varnish to resist damage from moisture and coating with salt.

Motors for the Battle Cruisers

The motors for the battle cruisers are of the same type, except that they are three phase and change poles at a ratio of 2 to 1 instead of 3 to 2. The latter ratio is an impossible one for three phase machines. Since greater speed must be developed, and consequently more horsepower, the motors are nearly twice as large on the *Iowa* and *Massachusetts* as on the *California* and *West Virginia*.

The type of motor which is used on cargo boats is an induction motor, designed for marine service, having a plain phase wound rotor with slip rings. Since starting and reversing are controlled by an external resistance, and since the maneuvering conditions such as those of battleships are not liable to arise, there is no necessity for two windings on the rotor. The pole changing feature of the battleship type of motor is also absent in these motors. In fact, they are a good deal the same as the motors of the collier *Jupiter*, which established the fact that electric drive was not only possible but highly desirable for ships of all classes.

Superheaters for the New Shawmut Steamers

In the description of the 10,500 deadweight ton cargo carriers which are under construction for the Shawmut Steamship Company, New York, at the Chester, Pa., yard of the Merchant Shipbuilding Corporation, published on page 714 of the September issue, it was stated that the steam pressure at the turbine throttle is to be 200 pounds per square inch without superheat. This statement is in error, as the Foster Marine Boiler Corporation, New York, has shipped to the Merchant Shipbuilding Corporation for installation in these two vessels eight Foster waste heat type superheaters designed to provide 50 degrees F. superheat.

Twin Screw Steamer Mashobra

THE combined cargo and passenger steamer *Mashobra* recently built by Messrs. Barclay, Curle & Company at the Clydeholm yard to the order of the British India Steam Navigation Company is the eighth of a similar type to be built by this firm for the British-India Company and is 464 feet long, 58 feet in breadth, and 36 feet in depth, with 11,000 tons deadweight carrying capacity.

Accommodation is provided amidships for about one hundred first-class passengers and fifty second-class passengers. The first-class dining saloon on the upper deck is fitted in mahogany and furnished with small dining tables in a manner similar to hotel service. At the forward end of the promenade deck are the first-class music and smoking rooms, while the corresponding rooms for the second class are at the after end of this deck. The staterooms for both passengers are quite elaborately fitted in order to give a maximum of comfort.

The cargo handling gear consists of two derricks, each of four tons lifting capacity fitted at every hatch, while a heavy derrick, capable of lifting up to 30 tons, is fitted on the foremast and a similar derrick with a 20-ton lift on the mainmast. The holds are left free and unobstructed for the stowage of bulk cargo by a careful arrangement of girders and wide-spaced pillars.

The vessel is of the twin screw type driven by two triple expansion, surface condensing engines supplied with steam from four single-ended boilers, working under Howden's forced draft, which are equipped for burning either coal or oil. The service speed of the vessel is about 14 knots.

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Steam Velocities and Pressure Drop in Superheaters

BY H. B. OATLEY*

From the earliest date when the advantages of superheated steam were recognized, one of the benefits found from its use was the possibility of using much higher steam velocities in piping, steam engine cylinders, turbines, etc., with less friction and pressure drop than with saturated steam. Throughout engineering literature this point is continually brought out. All engineers versed in this field have advocated steam velocities of 6,000 to 10,000 feet per minute in piping, and some highly successful power plants have been installed where such steam velocities in the piping are used. This also refers to turbine and engine designs, giving highly economical results.

WITH the rapid introduction of steam superheaters during the past decade, it is interesting to consider how the question of steam velocities has been regarded. In the majority of installations that have been made in stationary power plants velocities of from 1,000 to 4,000 feet per minute have been commonly used. In marine installations, as well as on locomotives, higher velocities are practically universal, running from 6,000 to 10,000 feet per minute and occasionally to 12,000 feet per minute. The advantages resulting from the use of what may be termed *high steam velocities* are sometimes overlooked in the effort to obtain the lowest possible drop in pressure between the boiler and the engine or turbine. While excessive pressure loss is to be avoided, the advantages of high steam velocities are of prime importance. These advantages may be stated as follows:

(1) Prevention of scale and the deposit of fouling material on the inside of superheater units.
(2) Sustained efficiency of the superheater resulting from the clean surfaces.
(3) Increased life of units due to No. 1 and No. 2.
(4) Decreased bulk and weight of superheater.
(5) Decreased obstruction to the flow of gases resulting from No. 4.
(6) Increased capacity of boiler and sustained efficiency at the higher ratings.

Importance of Clean Superheaters

Maintaining the interior surface of the superheater units in a clean condition is of the greatest importance. The accumulation of foreign matter, or even the formation of a very thin layer of scale, greatly reduces the heat transfer and efficiency of the superheater. The steam area is also decreased under such conditions, resulting in increased loss in pressure as well as decreased superheating capacity. Where higher steam velocities are provided for, the scouring action of the steam prevents the formation of scale and the deposit of fouling material. This fact has been fully substantiated in types of superheaters which have been designed to provide velocities as high as 12,000 feet per minute. In locomotive practice the world over high steam velocities are used, and in spite of the very severe service the cleanliness and long life of these units is well known. Many of them have been examined after a period of eight or even ten years' severe service and have been found entirely free of scale or foreign substances. This condition may well be considered remarkable when the very bad water conditions commonly encountered are considered. The freedom from scale accumulation is so consistent that it is not even considered in railway service.

In stationary power plant service, however, the accumulation of scale forming material in superheaters is frequently encountered and the topic is one of first consideration in most meetings of stationary engineering societies. An extract from a report on boilers and superheaters submitted by the committee on prime movers to the National Electric Light Association in 1919 will serve to illustrate the attitude on this subject:

"It (the superheater) should be opened up and thoroughly washed each time the boiler is out of service for general overhauling. * * *

"The internal condition of superheater may be regarded generally as being a very good indicator of wrong conditions within the boiler. If the superheater shows signs of mud or scale or other foreign matters, it is time corrective means be employed to remedy these conditions within the boiler."

Difficulty of Cleaning

The cleaning of the internal surfaces of a superheater is quite difficult, because of the difficulty in obtaining access to the ends of the superheater pipes. When cores are used there is the added labor due to the difficulty of removing the cores before the cleaning of the units can be accomplished. Superheaters are usually arranged with one or more loops, and it is difficult, if not impossible, thoroughly to clean the bent portion of the unit by means of the mechanical cleaners in use. When cores are used which do not extend around the bent portion of the unit pipe the deposit of scale forming material is at a maximum in the bent portion of the pipe because of the reduction in velocity of the steam and the ease with which foreign substance in the steam may adhere to the pipe. In addition, when this portion of the unit is located in high gas temperatures, deterioration of the pipe is very rapid.

The sustained efficiency obtained by keeping the steam as well as the gas touched surfaces of a superheater free from the accumulation of foreign material is a very well-known fact, although its importance is many times overlooked. The absorption of heat by the steam from a metallic surface is affected not only by the cleanliness of the metal but by the velocity both of the steam on the one side and the gases on the other side. Increasing the velocity of the steam increases the rate of heat transfer more rapidly than an increase in the flow of the gases past the superheating surface.

Life of Superheater

That the life of superheater units will be increased by the prevention of scale, and by maintaining the surfaces in a clean condition, is a self-evident fact. The surprisingly long life of units in both locomotive and marine service, particularly in connection with firetube boilers, is conclusive evidence of the beneficial results from maintaining cleanliness of superheating surfaces by providing both high steam velocities and smooth, easily cleaned gas touched surfaces.

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Decreased bulk of the superheater as well as decreased weight result from designing superheaters to provide for high steam velocities, and good practice in this respect is accompanied by a surprisingly small drop in pressure through the superheater. Superheaters with these characteristics will weigh from one-third to one-half as much as superheaters designed for low steam velocities. Loss in pressure of from three to ten pounds, when delivering from 150 degrees to 300 degrees of superheat, is commonly experienced. The advantages of decreased weight are apparent to all engineers when the conditions attending their installation and maintenance are considered. It is always necessary to inspect the interior of boilers and the exterior of superheaters at stated intervals, and it is often necessary to remove portions of the superheater in order to perform repairs and make replacements of boiler tubes and portions of the boiler setting. At such time the advantages of light and small superheater construction are apparent.

Obstruction to Flow of Gases

The obstruction to the flow of gases occasioned by the installation of superheaters has, until recent years, been given less attention than its importance warrants. The many tests on boilers fitted with superheaters have indicated that the maximum rating which it was possible to sustain has been occasioned by the obstruction due to the superheater. A decrease in the bulk of the superheater, causing less obstruction to the flow of the gases, has been demonstrated.

The increased capacities of the boiler, and an increase in the efficiency of the boiler at the higher ratings, have been demonstrated beyond question, and in some instances it has been proved that the removal of exceptionally large and bulky superheaters has permitted of an increase in the sustained high rating which the boiler could perform.

Steam Velocities

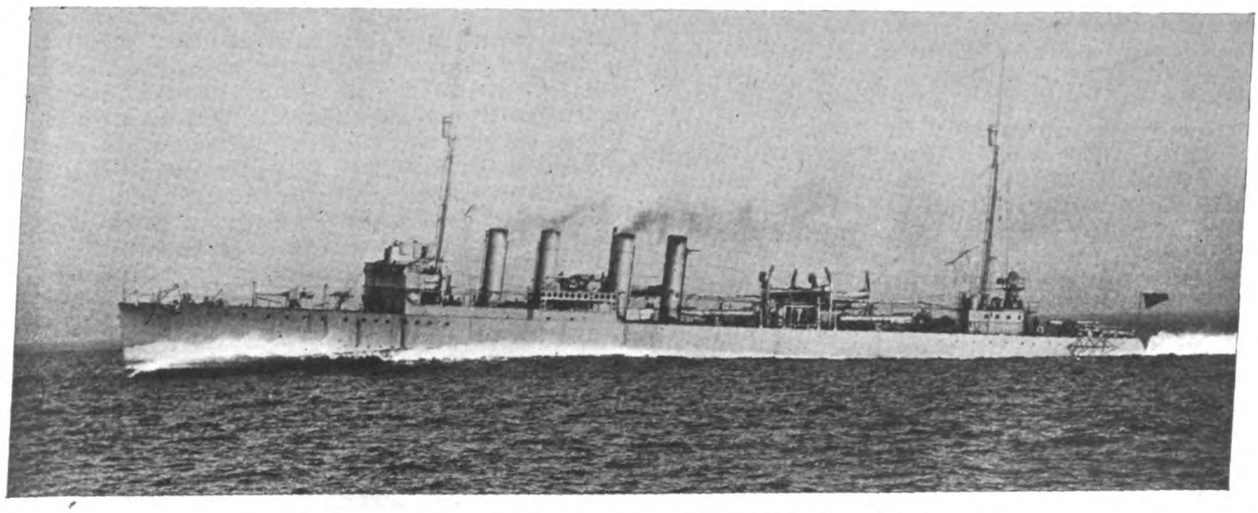
In considering the subject of steam velocities the question of drop in steam pressure through the superheater must be considered. It is generally understood that the pressure drop increases with the square of the velocity and, therefore, where high steam velocities are used a slightly higher pressure drop is to be expected. It appears, however, that the question of keeping the pressure drop down has been given consideration and discussion out of proportion to its importance.

It has come to the writer's attention that engineers have specified that superheaters should be designed for new plants with a pressure drop not to exceed 2 to 4 pounds. Why such limitations should be placed on a new boiler it is hard to understand, as the increased cost in designing a boiler, say, for 10 pounds higher pressure than would be expected at the superheater outlet is practically nil. Take a Stirling boiler with 3¼-inch tubes, for instance, and it will be noted that if the boiler were designed for 200 pounds pressure or more, which are the minimums now considered, it will be found that a No. 10 gage tube will be used. Inasmuch as the No. 10 3¼-inch tube, according to the American Society of Mechanical Engineers' Boiler Code, is good for pressures up to 276 pounds, there is leeway as far as the tube heating surface is concerned of 76 pounds without any additional cost. The only slight increase that there may be is possibly a 1/64 or 1/32 inch additional thickness in the drum, which, of course, is hardly noticeable in a new installation.

Higher Efficiency Compensates for Pressure Drop

For older installations where the margin between the maximum boiler pressure permitted and that required at the turbine, the question, of course, is of somewhat more importance, but it should be borne in mind that the increased superheat due to the higher efficiency of the higher velocity superheater for the same cost will compensate for a slightly higher pressure drop and the operator can afford to sacrifice a few pounds in pressure in order to gain the other very important advantages. In a great many existing plants it is quite possible to set the pops a few pounds higher to compensate for the slightly higher pressure drop.

In connection with the pressure drop through a superheater, it should be remembered that there is no thermodynamic loss of heat. For example, to increase the steam pressure 10 pounds from 185 to 195 pounds required only 9 British thermal units, or less than .7 percent of the total heat per pound of steam, and assuming that there is a 10-pound pressure drop through the superheater, the slight increase in the heat of the steam is not lost because it is absorbed by the steam in the form of superheat generated by the friction, which, of course, helps to raise the temperature of the steam.



Destroyer *Satterlee*. The Swiftest Vessel in the United States Navy

In her recent official trials the *Satterlee* broke all American speed records by steaming at a rate of 38.257 knots, the best previous record being 37.04 knots. She is driven by two Westinghouse geared turbines, which developed 31,223 horsepower and broke all power records for this class of vessel.

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Experience and Practice in Mechanical Reduction Gears in Warships*

Extreme Accuracy of Tooth Cutting Necessary—Typical Gear Ratios in Naval Practice—Material for Pinions—Reliability and Economy Proved

BY ENGINEER-COMMANDER H. B. TOSTEVIN, D.S.O., R.N.

A difficulty in the early history of gear cutting was caused by the fact that the master worm wheel which rotated the gear wheel during the cutting operation was not quite accurate; this difficulty led to an addition to the machines of a "creep" mechanism, by means of which the job is rotated at a higher speed than the table. Any recurring error in the worm wheel which might be copied on the job being cut is, with such a machine, no longer in the direction of the axis, but is distributed in helices on the gear wheel or pinion. With improvements in the accuracy of this master worm wheel and the maintenance of the machine in good condition with all parts well lubricated during a cutting operation, the advantage derived from the use of the "creep" has been lessened, and from a list of ten firms that have cut the majority of the naval gears it is a matter of interest that on the wheel machines only four, and on the pinion machines six, firms use "creep." As regards the tendency of the worm wheel to wear out of truth, inquiry has shown that in a number of machines that have been working constantly for at least three years the accuracy has not been affected.

Extreme Accuracy of Tooth Cutting Necessary

Experience indicates that extreme accuracy of tooth cutting and the maintenance of accurate alinement are necessary to the successful operation of any mechanical reduction gear. In all naval work the turbine spindles, pinions and gear wheels are supported on rigid bearings, and the alinement is determined by accurate machine work in boring the gear housings and fitting the bearings. No gears of the floating frame type, in which the pinions and bearings are mounted in a frame supported on a flexible I-beam, which automatically maintains its correct position after being accurately alined in the first place, have been fitted, and judging from the general experience obtained over a number of years, it appears that any advantage likely to accrue from the adoption of such a system would be outweighed by its disadvantages. The important feature that must be borne in mind is that all calculations of tooth stress and dimensions of the surfaces required between the working faces of the teeth, the design and construction should be such that the total tooth pressure is uniformly distributed over the whole width of the tooth face, but various conditions arise in practice which tend to upset this working. Misalinement is one cause, and it emphasises the special care necessary in this particular. In some designs the turbines and gear cases were carried on separate supports built up from the hull structure. The turbines and gear cases as separate units are of stiff construction, and under working conditions do not suffer distortion. The possibility of relative motion between the turbines and gear case existed, and although nearly all vessels so constructed experienced no troubles with the gearing, yet in two torpedo-boat destroyers the gear became very noisy, and wear took place on the teeth. Although no actual breakdown occurred, the defects were objectionable, and the gears were removed for dressing up. When the alinement was again tested it was conclusively proved that relative displacement of the gear case and turbines had actually taken place. In later designs this movement is not possible, as the after ends of the turbines are now supported on stiff extensions of the gear case, the whole installation forming a rigid unit. This is illustrated in Fig. 15.

Owing to the action between the teeth when transmitting power, the pinion and wheel tend to increase their distance between centers. This, as pointed out, does not affect the smooth or regular action of involute teeth, but the line of centers through turbine and pinion should be free to remain parallel with the axis of the wheel, and the clearances in all the bearings should permit of this, otherwise misalinement will take place. Another cause that arises is that due to the deflection of the pinions and wheel, which in each case is of a double nature, viz., that due to the twist and that due to the bending. These points should not be overlooked in any design, but with the proportions brought about by other considerations these deflections are not such as materially to affect the working of a correctly constructed gear.

Unequal Distribution of Load

Apart from the above causes it has been observed in many gears that the load has not been distributed over the whole length of the teeth, and undesirable concentration of pressure having taken place on a portion of the length. This does not appear to be due to distortion under the twisting moment, as it has been observed at either of the ends of the pinion elements, and it has been attributed rather to an error in manufacture, the helical angle of the pinion element being slightly different from that of the gear wheel. It is necessary that particular attention should be paid to this important point right through the construction of gears, as many makers appear to be satisfied to assume that as this helical angle is a function of the machine mechanism, the angle will necessarily be correct or at least within a microscopic difference. Unfortunately, in some cases this has been found to be far from true, especially in the case of pinions, and it points to some torsional movement of the job during the cut. This may occur through strain of the driving mechanism when taking a heavy cut or a slight, slow slip of the pinion in the chuck of the machine. It appears better that nothing should be left to chance, and that the angle should be tested after the gear is cut and before the work is removed from the machine, either by again running the hob through it so as just to touch the surface or by a separate checking arrangement.

It is also to be noticed that even with an accurate helical angle of the components of the gear and correct alinement perfect contact is not necessarily obtained, as, owing to the hob receiving a certain feed for each revolution of the wheel or pinion being cut, the working face of the tooth is more in the nature of a number of facets than a fair

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curve. This is accentuated when the teeth are shaped in a single operation, as favored by the majority of gear cutters, and the faces are often observed to have a torn or scored appearance in the direction of the cut. It is a question, therefore, both from the point of view of correcting small errors in helical angle and the formation of fairer surfaces, whether a slight finishing cut should be taken and then the hob run through again in a different relative position to that in which the main cut was taken so as to remove the high points between the facets and to smooth the surfaces that have been torn, due to the hardness of the material when taking the primary cut.

The speed of the teeth has an effect on the running and durability of the gear, owing to the intensity of shock on them. With the modern methods of cutting and manufacture, and with forged materials, the limits formerly

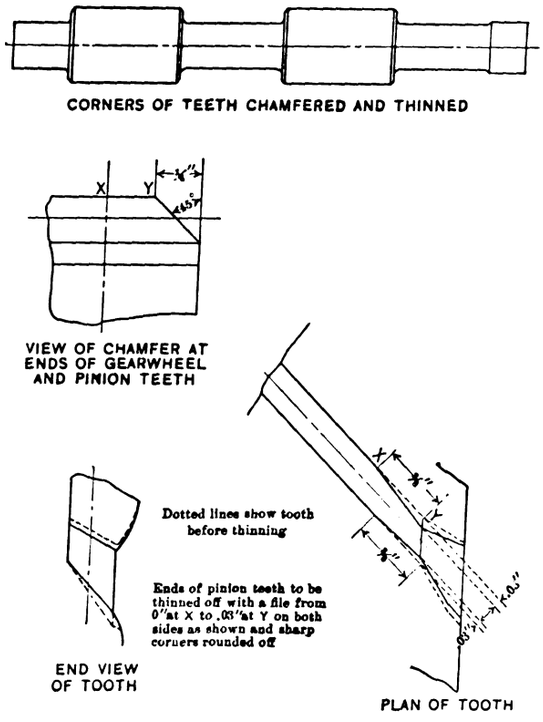
CORNERS OF TEETH CHAMFERED AND THINNED
VIEW OF CHAMFER AT ENDS OF GEARWHEEL AND PINION TEETH
Dotted lines show tooth before thinning
Ends of pinion teeth to be thinned off with a file from 0" at X to .03" at Y on both sides as shown and sharp corners rounded off
END VIEW OF TOOTH
PLAN OF TOOTH

Fig. 13.—Chamfering of Pinion Teeth

used with spur gearing have been much exceeded, and there is ample experience to prove that satisfactory working can be obtained with speeds of 140 feet per second, and there seems no reason to assume that this speed could not be sensibly exceeded. The effect of the rise of temperature on the teeth, due to the rubbing contact when off the pitch line, has not appeared to be sufficient to affect the working in a well lubricated gear. In general, a gearing ratio of 8 or 9 to 1 is not exceeded in naval practice of moderate and high power.

Typical gear ratios from naval practice are given in the following table:

Type	Shaft Horsepower per Pinion		Ratio of Turbine Revolutions to Propeller Revolutions	
	High Pressure	Low Pressure	High Pressure	Low Pressure
Battle cruiser	17,500	18,500	7.1	5.2
Light cruiser	8,500	11,500	9.3	5.1
Flotilla leader	9,000	11,000	8.3	5.0
T. B. D.	6,250	7,250	8.5	6.5
"K" boat	2,250	2,250	8.7	7.7
"P" boat	875	875	11.6	11.6

In the design of a reduction gear the question of relative axial movement between the pinion and the gear wheel is of importance. This movement takes place due to the necessity of the pinion requiring to adapt itself so that the load on each element should be the same. This movement is not difficult to cater for in a single reduction, as the gear wheel being fixed by the thrust block it is only necessary to provide an expansion coupling between

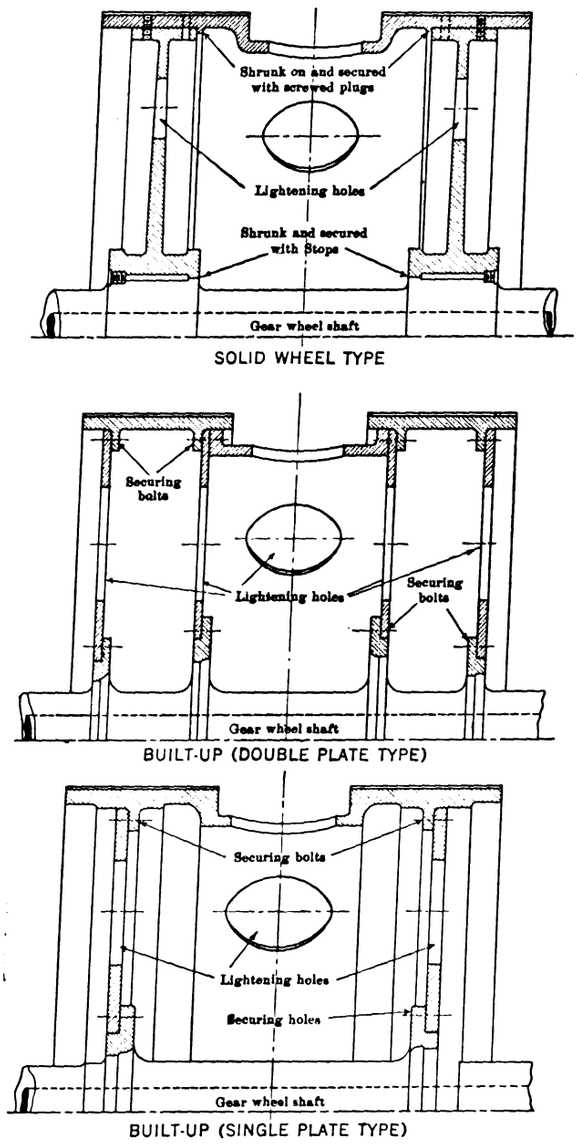

Fig. 14.—Types of Gear Wheels

pinion and turbine spindle, and allow clearance between the ends of the pinion elements and the adjacent bearings. The problem is, however, more difficult in the case of certain designs of double reduction gear, as relative movement is required between the shaft gear wheel and the intermediate reduction element, and also between the latter and the pinion. The intermediate reduction wheel being a heavy fitting, for it carries four working faces, two of fairly large diameter and two small, possesses considerably more inertia than a pinion, and in the event of fitting such a gear in warships this aspect of the problem would require careful consideration.

To avoid the same teeth of pinion and gear wheel coming in contact revolution after revolution, and also to in-

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sure uniform wear, it is usual to fix the gearing ratio so that it is not only not a whole number, but the number of teeth in the wheel and pinion have no factor in common. This is seen in Table I (see page 750, September issue).

In addition to the two cases of trouble with gearing previously referred to, there have been a few cases of failure due to the fracture of pinion teeth at their ends. This is the weakest part of the teeth, as no support is given on one side of the portion receiving the pressure. Chamfering off of the ends of the pinion teeth, as shown in Fig. 13, prevents the load coming on the extremity. Fracture of these teeth might be expected with an error in the helical angle of the components, leading to an excessive intensity of pressure at one end of an element, but cases have occurred where a fracture has taken place, and yet an examination of the gears has shown the pressure to be uniformly distributed along the length of the tooth. Seeing that under these conditions the tooth stress is low, other reasons have been sought for these failures. Of the six cases, four occurred during the contractors' trials, one occurred after two and a half months, and the other after seven months' service. In neither of the latter two cases has the defective gear been removed from the vessel, and they are still running with the broken teeth having been trimmed off and the gears dressed up.

Defective material has been indicated as the probable cause of this defect, but although careful analysis has been made, in no cases have the results indicated anything seriously wrong with the metal, although it has been noted in one or two cases that the structure has not been the best possible. It should be noted that before the vessel has been accepted by the Admiralty the teeth of the high pressure pinion in a destroyer have received their full load about a million times, and in the case of a light cruiser about 600,000 times, and the causes of failure referred to may, in the absence of any other reasonable cause, be attributed to a fatigue at a flaw developed in the alloy during its manufacture.

Materials for Pinions

The type of steel used for pinions must possess several essential qualities, viz., (*a*) strength to resist permanent deformation under stress; (*b*) stiffness, to avoid undue whip or elastic deformation when running; (*c*) surface hardness to prevent wear; (*d*) non-brittleness, so that it can stand shocks and blows.

In addition, there is the important fact that the teeth have to be cut after tempering the material, as otherwise distortion of the teeth would arise.

The specifications governing the materials for gear forgings for naval service and their treatment are given in the Appendix.

It appears that finality in respect to the most suitable material for pinions has not been reached, and it is possible in future that the use of a chrome-nickel steel with a low percentage of chromium, say from 0.3 to 0.5 percent, will receive consideration for these details in place of the nickel steel now employed. It is known that the effect of very slight variations in the percentage of the constituents, variations that may occur in different parts of the forging under the best conditions, are sufficient completely to upset the anticipated results of the heat treatment, but judging generally from experience with service gears there does not seem any pressing reason to depart from present practice.

Before a vessel is accepted by the Admiralty the gears are opened up after the full power trials and all surfaces, especially the roots and ends of the teeth, scrupulously examined with a powerful magnifying glass to ascertain whether there are any flaws or signs of cracking present that may lead to subsequent fatigue failures.

During the early running of gears on service there is often observed on the faces of the teeth an action known as pitting. Small flakes of metal are detached from the otherwise smooth surface of the teeth, leaving small hollow depressions, varying in size from a small speck to as large as ⅛-inch diameter, and 15 to 30 thousandths of an inch deep. They are most common in the region of the pitch line, where only rolling action occurs. It is difficult to account entirely for this pitting. A lack of homogeneity in the material at the tooth surface (and careful analysis by micro-photography does reveal this), or crushing of minute high spots causing failure of small sections of the metal at these high spots are possible reasons for this pitting. This action in the vicinity of the pitch line may possibly be due to the metallic contact recurring there as a result of the failure of the oil film, observing that the rubbing velocity of the teeth is gradually reduced from a maximum at the tips and root to zero at the pitch line. In any case, the action is not found to be deleterious to the smooth and efficient working, and it usually ceases after a short time.

Deformation of Teeth a Serious Fault

Deformation leading to scoring and wear of the teeth is a serious, but fortunately rare, fault in naval gears, and the only cases on service in which such wear has taken place were those previously referred to as having suffered from misalinement and in the case of a "P" boat referred to later. It has, however, taken place during the contractors' trials of at least two ships, involving removal with either re-cutting to a modified form of tooth, necessitated by the wear, or the substitution of another gear. The working is seriously prejudiced by such wear, as, apart from the reduction of life involved, it is accompanied by excessive noise and heavy "shivering" of the gear, which transmits its effects to the turbines and subsidiary fittings, causing failure of lubricating pipes, etc. Once deformation is present, or sets in, the whole face of the tooth is affected, even at the pitch line, where the contact is more of a rolling nature, as, due to the wear of the faces of the teeth, there is a tendency for the points of the harder pinion teeth to "dig in" and tear across the flank of the tooth when disengaging, the concentration of the load on the pitch line then being so great as to cause elastic deformation and a continuation of the digging in, failure of the oil film takes place, and the whole surface of the tooth is scraped away. In the two cases referred to, during trials some slight error in the tooth form was considered to have been the cause in initiating the action, being then accentuated by the consequent failure of the oil film.

From this same point of view any grinding in of the gears, apart from the practical difficulties of carrying it out, appears to be undesirable on theoretical grounds, and as it causes wear of the flanks and faces of the teeth, it leads to an undue concentration of pressure on the pitch line. A few service gears have been subjected to this operation, but it is not now being applied.

Another usual feature in gears during their early life is for a minor action of the above nature to take place, the teeth at the regions of higher pressure being rubbed away, or caused to flow so that a sharp razor like edge or small "rag" is formed on the points of the teeth. It can be stated as a general principle, however, that once these harder regions of pressure have been "beaten down," the load is more uniformly distributed and the action does not continue, nor is the working of the gear affected.

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With the oils used for naval service, corrosion of the gears does not take place. Some slight admixture of water with the oil always takes place, chiefly due to steam from the turbine glands entering the adjacent bearings, but beyond a rusting effect of the wheels and pinions generally the working faces are not affected. It has been suggested that in the early life of a gear it might be advisable to use an oil carrying a proportion of graphite, from the point of view that under the working pressure the microscopic irregularities in the surfaces would be filled by small particles, and in a short time highly polished surfaces obtained. As the lubricating system of gearing is, however, common with that of the turbine installation, it has not been generally adopted, but recently this is being tried in two torpedo-boat destroyers.

From the general experience so far gained there is no reason to suppose that gearing should not have a long life, provided that a reasonable amount of care be exercised in running an installation that has successfully passed through its specified trials. Gages are supplied for testing the wear of the teeth, but as in practically all cases the wear is inconsiderable, it is not usual to keep records of this.

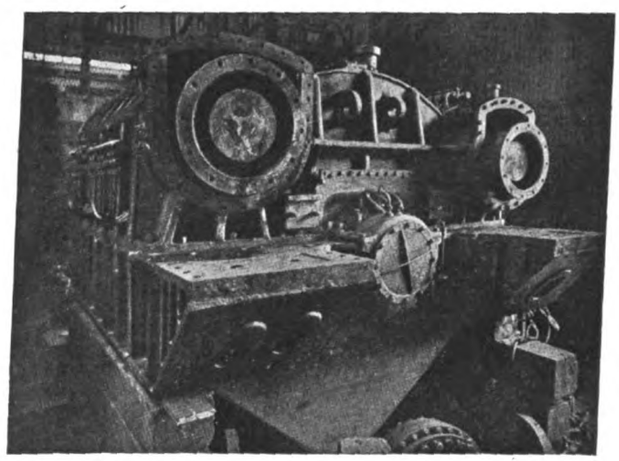

Fig. 15.—Extension of Gear Case for Support of Turbine

PROOF OF RELIABILITY

Some cases of failure having been mentioned, it is of interest to sum up as a whole and see how far the anticipation of reliability has been substantiated. Of the *five hundred and fifty-six* sets of all-geared installations on service in the navy, some extending up to nearly six years, it has only been necessary actually to remove *three* for refit in the misalinement cases referred to, and here it must be emphasized that no actual breakdown occurred, and the gears, after dressing up and in one case new pinions being supplied, were subsequently re-utilized. Also in the case of one of the "P" boats the two gears had to be removed on service owing to their becoming noisy and wearing slightly. The wheels were "dressed up" and new pinions fitted. Of the cases of fractured teeth, which are two in number, the gears were not removed, the broken or cracked portions being removed and damaged teeth smoothed up. In another case a breakdown occurred through a ⅞-inch bolt, inadvertently left in the gear case, passing between pinion and wheel and damaging a portion of the length. This set was replaced by a spare, but the old wheel after cleaning up is retained as a spare with 3 inches of the tooth face out of 40 inches total missing. The failures on trials have been four with fractured teeth and two with excessive wear, and it must be admitted that these figures are most satisfactory when it is remembered that the development and experience of these gears for high powers was, except for a few cases, confined to warships.

Apart from the reduction in size of the turbines which led to more rigid and reliable units, there is a great decrease in the quantity of turbine blading required, and at one period of the war, owing to the enormous demands for copper in the munitions, etc., service generally, any question which lessened the demand for the supply of this metal or its alloys was of importance, and the reduction in blading required owing to the adoption of the all-geared installations reduced the strain on the blading makers and avoided any possible delay in the construction of warships from this cause.

QUANTITY OF TURBINE BLADING REDUCED

Some typical figures showing this are: In a direct driven torpedo-boat destroyer of 25,000 shaft horsepower the total length of blading sections fitted is approximately 70,000 feet as compared with 7,720 feet in an all-geared installation of 27,000 shaft horsepower. As, however, the section of the blading in the all-geared type is heavier, the weight is not in the same proportion, being as 4 to 8½ tons. Apart from the saving of fuel and slight reduction in boilers owing to the gain in economy, there is no great saving of overall weight in the all-geared installation, the gearing being a heavy fitting and helping to outweigh any saving obtained on turbines and boilers. Some typical weights are:

		Shaft Horse-power	Total weight, tons	Shaft Horse-power per ton
Torpedo-boat destroyer	Direct driven	25,000	372	67.5
	All-geared	27,000	393	69.0
Flotilla leader	Direct driven	36,000	554	65.0
	All-geared	40,000	615	65.0

ECONOMY SUBSTANTIATED

The question of economy which was one of the primary reasons for fitting reduction gearings has been substantiated. Generally speaking, the advantages of the present all-geared installations over the most recent direct drive types fitted are shown in the above table, the figures being based on the increase of the radius of action for the same quantity of fuel under service conditions, and therefore taking into account the gain in economy in the turbines and the effect of an increase in propulsive efficiency.

PERCENTAGE INCREASE IN EFFICIENCY OF GEARED INSTALLATIONS

	One-fifth power	Two-fifths to Three-fifths power	Full power
Light cruisers	16.5	16.3	16.1
Flotilla leaders	20.0	20.0	17.0 } at 30 knots
Torpedoboat destroyer	20.0	20.0	20.0 }

The initial steam conditions in the cases of the all-geared and direct drive installations are the same in each case.

It should also be noted in this particular that superheated steam has not up to the present been used in any all-geared turbine installation in the naval service, but with the advantages to be gained from the possible adoption in the future the smaller rigid turbines used would conceivably be more adapted for superheat than the larger direct drive units.

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Review of Motorship Machinery Problems

Opposed Piston Type Engines—Novel Scavenging Pumps—Engine Room Arrangements and Auxiliaries—Diesel Electric Drive

BY HUBERT C. VERHEY

SUCCESSES obtained with single acting heavy oil engines caused engineers and manufacturers to go a step further in an attempt to approach the good points of reciprocating steam engines, so that experiments were started in Germany to produce double acting motors. This is a difficult problem in oil engine design as a stuffing box for the lower end of the working cylinder has to be used. Increased heat conditions to which the piston is subjected require special care for the cooling system. Furthermore, the construction of the lower head is special owing to the passing of the piston rod, so that the valves must be located accordingly, which invites complication. In principle, the double acting engine is ideal, and for that reason the future may have good mechanical solutions in store, as a minimum height can thus be obtained, which is of importance on board ship.

Opposed Piston Type

Engines of the Junkers type with opposed working pistons have eliminated stuffing boxes and cylinder heads, thus rendering a very simple looking working cylinder, but they are comparatively high owing to the necessity of an overhead drive for the upper piston, the movement of which is transmitted to the crankshaft by means of two long connecting rods engaging two cranks, located respectively, one on each side of a centercrank which operates the lower piston. The two outer cranks and the middle crank are set 180 degrees apart. This system offers a good balance. Two bearings are available for three cranks, thus making a long distance between the main bearings, so that the dimensions of the crank shaft, and in particular the center crank webs, must be such that care is taken of this leverage.

The fuel consumption of this type of engine is apt to be a trifle higher than the single acting two cycle engine, having a double port scavenging system, as it is not possible to start the compression stroke at a point where the available air is above atmospheric pressure.

Although the scavenging air used naturally has a pressure above the atmosphere, the advantage of this, which is utilized in the double port systems, goes for naught in this case, due to a lead required for the exhaust ports in order to reduce the prevailing pressure at the end of the expansion stroke to atmospheric pressure necessary to allow the scavenging air to enter and drive the exhaust gases out.

The same feature occurs in single acting single port scavenging engines, as the lead described above cannot be avoided and thus affects the fuel economy.

Doxford engines built in England are based on the Junker's principle and are soon expected to show their merits in actual seagoing performance in large cargo vessels. The manufacturers of these engines have also adopted the solid fuel injection system, so that their products can be regarded to represent modern practice. In the future when data obtained in actual service are available and proof has been established that the great height as compared with single acting engines of the same bore and stroke is no detriment, the opposed piston construction is bound to have a field of adoption, as considerable reduction in overall length can thus be obtained and space on board ship is an important point. For direct drive installations there is plenty of head room available in the engine room, and with adequate handling facilities and care taken for the accessibility of all parts these motors may play an important part in future developments of motorships.

Cammell-Laird Engine

England, furthermore, deserves credit for additional development of opposed piston type heavy oil motors. The Cammell-Laird engine based on the Fullagar principle embodies the Junker's type as far as the opposed piston arrangement is concerned, but in this case two working cylinders each having two pistons moving therein are placed side by side.

The respective pairs of pistons are made to act on only two cranks for the whole combination. Diagonal tie rods are provided which connect the upper piston of one cylinder to the lower piston of the adjacent cylinder and vice versa.

This means that each crank transmits the work of one working stroke and one compression stroke simultaneously, which practically makes the whole crank shaft a floating shaft, as the cranks are set at 180 degrees apart.

Two bearings are necessary to take care of the two cranks, which in turn handle all four pistons by means of two connecting rods, whereas the Doxford engine would require six cranks and as many connecting rods to transmit the work of the same number of pistons to the crank shaft.

Fullagar Engine Crosshead

A distinct departure from the ordinary reciprocating engine practice is the crosshead construction of the Fullagar engine. In addition to the usual inboard thrust of the connecting rods, this crosshead is compelled to take care of a longitudinal thrust due to the angularity of the tie rods connecting the respective pistons, a feature which has yet to demonstrate its endurance and reliability on board ship in large size engines. They have not yet been in actual service, although they are in course of construction.

Scavenging Pumps

Another novel construction is in the scavenging pumps, which are located on top of the respective working cylinders. They are attached to crossheads of the upper pistons to which the tie rods are also connected. The pumps are of the single acting type and the pistons have a rectangular shape, which, although unusual, should not fail to perform with the very low scavenging air pressures required. If the leakage of fuel gases past the upper working pistons can be prevented, the walls of the scavenging pumps and also the tightening strips which do the same work as the piston ring in a cylindrical pump may remain free of carbon and gum formation. There is a tendency, however, to draw the foul gases upward toward the scavenging pump walls due to the suction action of the piston when moving upward.

Experience has shown that the mixing of lubricating oil with foul gases gives trouble which did occur with single acting two cycle engines having a scavenging piston at-

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tached directly underneath the working piston—engines of the so-called step piston type. Leaking pistons would discharge exhaust gases past the working piston, which gases entered the scavenging pump and caused difficulties affecting the reliability of operation.

ARRANGEMENT OF SCAVENGING PUMPS

The arrangement of the scavenging pumps in the Fullagar engine has reduced the well-balanced work on the crank shaft to a certain extent and also has increased the height. In time, however, we shall have actual performance data about these novelties. It will eventually be perfectly possible to omit the scavenging pumps from the main engines by installing independent driven scavenging units, such as is now contemplated by builders of single acting two cycle engines, which can be either a reciprocating pump or a rotary blower. The independent unit would also improve the all-around scavenging process, as the amount of air required while the engine is running at variable speeds could be properly regulated.

Cammell-Laird did not adopt the solid fuel injective system, but maintained the use of an air compressor for fuel injection. The engine as a whole is a rather radical departure of prevailing practice, and it is therefore of interest to follow its accomplishments. With the same number of working pistons of the same diameter and stroke, it can be built shorter than the Doxford type, which is another step in the direction of saving of cargo space.

CYLINDERS

Cylinder bores up to about 30 inches are as far as manufacturers, backed by years of experience, have been able to produce good results. It is known that the larger the cylinder bore, the greater the problem and that more care has to be taken with the design and the production of suitable castings. It is one of the arguments advanced by non-believers in the future of heavy oil motors for marine use in direct driven installations.

FIRST COST

A real argument, however, is left in the hands of those who are unwilling at present to accept the claims of direct oil burning propulsive machinery without reserve, which is that the weights and the price of installations are high. Particularly, the price is a handicap at present, notwithstanding the undisputed fuel economy, but no manufacturer of heavy oil motors in the world has ever had a chance to compete with engines manufactured on a production basis, such as has been the good luck of steam power builders. Comparisons with steam installations are usually based on the available data of successful four cycle single acting installations, builders of which make it appear as if there is only a slight chance of introducing reliable two cycle installations. However, the advancement made in the art will be the future judge.

ARRANGEMENT

Engine room arrangements with four cycle engines have practically reached a stage where everything is more or less standardized, so that further saving in space cannot be expected. The length required does not differ much from the space occupied by geared turbine installations using oil fired watertube boilers. Large two cycle installations cannot yet be referred to in cargo vessels, although the future will surely belong to the latter type of engine, owing to the possibility of a saving in weight per horsepower and also a saving in length. The question may be raised where such installations can be found in actual service, thus forming a weapon in the hands of those strongly favoring the four cycle principle. It should not be forgotten that the European countries which developed successful four cycle installations had the backing of their respective shipowners and thus a ready market for their products. Such encouragement counts for a whole lot during the period of development, and where eventually good results are obtained it is only natural that no departure is contemplated for good business reasons. Two cycle motor builders have lacked this appreciable support.

DIESEL ELECTRIC DRIVE

Further efforts are now being made to develop Diesel electric propulsion which tends to lead the heavy oil motor industry into different channels again. The thought is not new and the attempt is a result of experience obtained from turbo-electro installations. High speed turbines, the most economical of their kind, direct coupled to generators of moderate size, have been tried out and are in use. The thought arose to utilize the greater economy of the Diesel motor by coupling them to generators and producing current for motor attached direct to the propeller shaft. At this point a compromise becomes necessary, as the high speed Diesel motor is a different proposition as compared with the slow speed engine. There is a limit to the number of revolutions at which a high speed engine can be built, for stability and endurance and careful consideration must be given to all pros and cons.

Assuming that we are willing to sacrifice the better fuel economy of the slow speed engine for a possible gain in weight and size of the engine, we must also keep an eye open to the fact that we are adding a generator to each oil motor unit applied, in addition to the motors on the propeller shaft and all further electrical apparatus involved.

The flexibility in operation of such an installation cannot be disputed, although no arguments can be advanced against direct drive with large units as far as the maneuvering ability is concerned, as good oil motors can be handled as readily as steam engines.

It is not my intention to go deeper into the subject of comparison in this article. I feel there is a place for both schemes and no doubt the study that is being given the subject will reveal many points of interest to the maritime world, particularly in cases where we lack sufficient comparative data at present. It merely goes to prove that many different solutions are thought of, and we know that competition invariably promotes development.

STEAM INSTALLATIONS

During recent years the economy of steam installations has also been materially improved. High speed turbines with reduction gears for the maintenance of good propeller efficiency have been built in great numbers. They had their troubles, which in the majority of cases have been overcome, merely illustrating what can be done if an actual desire to develop certain mechanical possibilities is dominating.

Turbo-electric drive is also considered. This offers the advantage of the high speed of the turbine in combination with the consequent small size of the electric generator. These installations will eventually be developed to a point of reliability as many efforts are being made nowadays which means success in the end.

It is therefore no wonder that the engineering world pays due attention to a combination of the economy of the direct burning heavy oil engine with the merits of electric machinery. The tendency is to try to bring about a suitable solution for America's problems of competition with seafaring nations to the best advantage.

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There are many other angles to the whole situation, and a great field is opened for American manufacturers to bring on the market a line of auxiliaries that are the most suitable on board motorships.

AUXILIARIES

Electric motors are used to run the various pumps. They are invariably of the enclosed type. Considerable study is necessary to determine the proper combination in compact units of the water and oil circulation pumps, the ballast and bilge pumps, etc. It will require the co-operation of the respective manufacturers. Up to this time the buyer of such equipment has been more or less handicapped because, as a rule, standard equipment was offered which had to be assembled to suit the standard features of either electric motors or pumps. Right here is plenty of need for improvement, which the future is sure to bring.

For some time to come, however, we may expect a period of uncertainty on the part of the manufacturer, as it is extremely hard to determine in what direction to standardize. This, naturally, will not be of direct benefit to the ready adoption of motorships, as many talking points will be raised about this handicap. American shipowners are compelled to weigh every item carefully and are mostly interested in the actual cost per ton-mile. A tendency which shows that the motorship has come to stay cannot be denied, regardless of the present handicaps.

Production will eventually flourish, as we have the shops and the manufacturing facilities, and last, but not least, the material. Two of our large concerns have built and are now trying out big engines of 2,000 and 3,000 horsepower of their own design, and from all indications they will be successful.

The world's fuel problem has become so acute that failure to look the actual situation square in the eye may mean the loss of our prestige as a maritime nation. With the limited oil supply now prevailing, machinery that conserves fuel should have a good chance to be in demand. In this way the handicap of price becomes a secondary matter, and with the extended use of heavy oil, marine engine manufacturers are in a better position to meet competitive requirements.

For ships going on long voyages the Diesel installations are the most economical and prove to hold their own regardless of the higher initial cost. Let us therefore hope that our Government, which has now been authorized by the Jones bill to finance the development of the most economical class of machinery, will give her support to manufacturers and shipbuilders who believe that the direct heavy oil burning motor has a great future.

BUREAU TO MODIFY RULES

One of our foremost institutions, the American Bureau of Shipping, can be highly complimented on their recent step of appointing a committee of experts in Diesel engine and motorship construction to revise and modernize the rules for the survey and classification of motorships. This will eventually lead to a reduction in insurance rates, which has also been a handicap to motorship development.

The greater part of America's motorships are small and equipped with hot bulb engines or gasoline motors. Both of these types offer more fire risk than Diesel installations, especially when installed in wooden hulls.

Speaking of motorships and discussing their general features, it invariably happens that comparisons are made with installations of this kind, which is by no means fair. A motorship equipped with modern engines of the straight Diesel principle does not invite fire risk and therefore may be considered as foolproof as any oil burning installation for the simple reason that all oil is stored in the double bottom of this ship, which is properly ventilated with vents leading to the atmosphere on deck. There are no external parts exposed to heat, there are no sparks flying and the oil used has a very high flashpoint—factors which have apparently been overlooked by experts who fix the insurance rates.

Comparative Trials of "Still" and "Sulzer" Engines Under Actual Working Conditions on Board Ship*

BY WILLIAM DENNY

IN the year 1913, Messrs. William Denny & Brothers took out a license from the firm of Sulzer Brothers, Winterthur, for their special type of oil engines. To obtain experience in the manufacture of such engines they arranged to proceed with small twin screw engines of about 250 indicated horsepower in all and to build a hull in which these engines would be thoroughly tested. Both the hull and the power of the engines arranged for corresponded with a standard type of light draft passenger and cargo steamer, of which a number had been built for service in the rivers of India and Burmah. These vessels

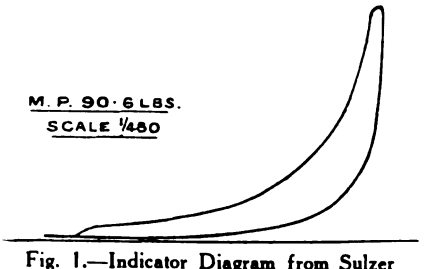

Fig. 1.—Indicator Diagram from Sulzer Engines

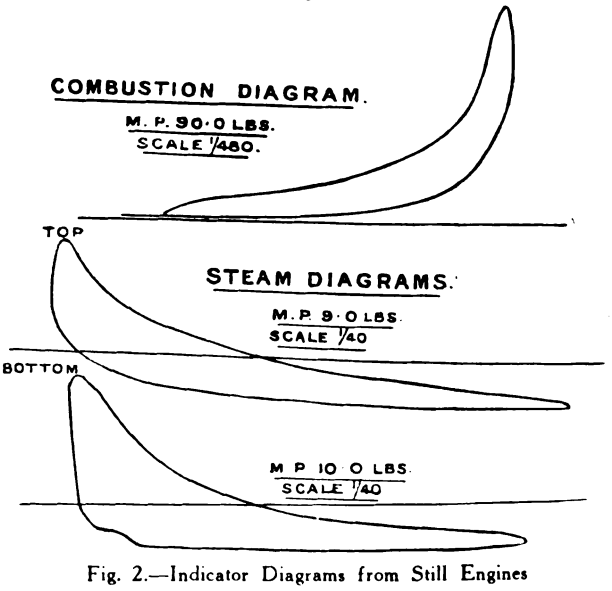

Fig. 2.—Indicator Diagrams from Still Engines

are 100 feet long, 23 feet 6 inches beam, and 7 feet 6 inches deep, and have an approximate speed of 10 knots with 250 indicated horsepower. When war broke out, the hull and engines for this experiment were well advanced, but under "control" conditions the work on them was stopped to make way for the pressing requirements of the Government.

For some time before the war the firm had been inter-

* From a paper read at the summer meetings of the sixty-first session of the Institution of Naval Architects, Liverpool, England, July 8, 1920.

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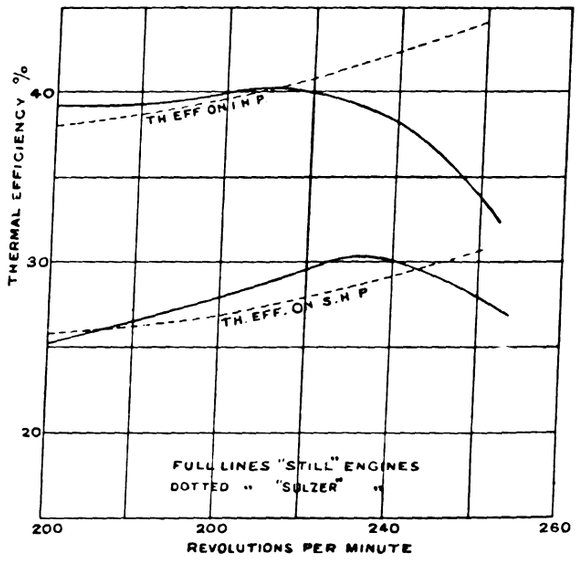

Fig. 3.—Fuel Shale Oil. Specific Gravity (.85) at 60 Degrees F. Caloric Value About 19,000 B. T. U. (Gross)

ested in the "Still" engine; fairly early in the war period it was arranged, with the consent of the Admiralty, that an experimental Still installation, to correspond with the hull already mentioned, should be proceeded with, being twin-screw engines of, in all, about 250 indicated horsepower. This arrangement was carried out and the vessel with the Still engine was exhaustively tried.

On the conclusion of the war it was decided to complete the original set of Sulzer engines and fit them to the same hull, the Still installation, so far as necessary, being, of course, removed from the vessel. This experiment also was duly carried out and the results with both types of engines are given later.

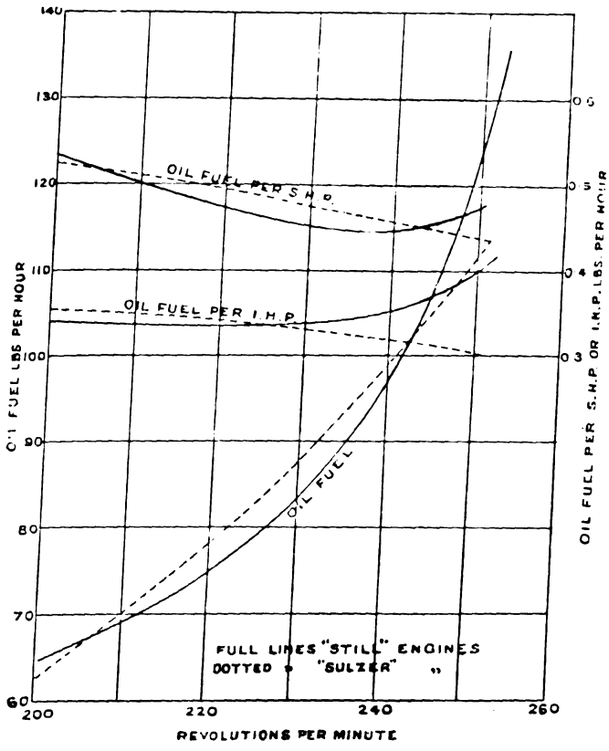

Fig. 4.—Oil Consumption

In carrying out these comparative trials, everything possible was done to ensure that the results in all respects would be reliable; the same oil was used, the same propellers, the same draft, the vessel was run on the mile to check the speed in terms of revolutions, the oil consumption trials were repeated several times, and during each trial were checked at stated time intervals, and it is considered that the results as given may be regarded as reliable.

The Sulzer type of oil engine is well known, and the Still system has been fully described in a paper read by Captain F. E. D. Acland before the Royal Society of Arts on May 26, 1919, but for the information of those who have not yet read that paper it may be stated briefly that the "Still" type of engine is a combination of the steam and of the internal combustion engine, steam acting on one side of the piston while oil combustion takes place on the other side, within the same cylinder.

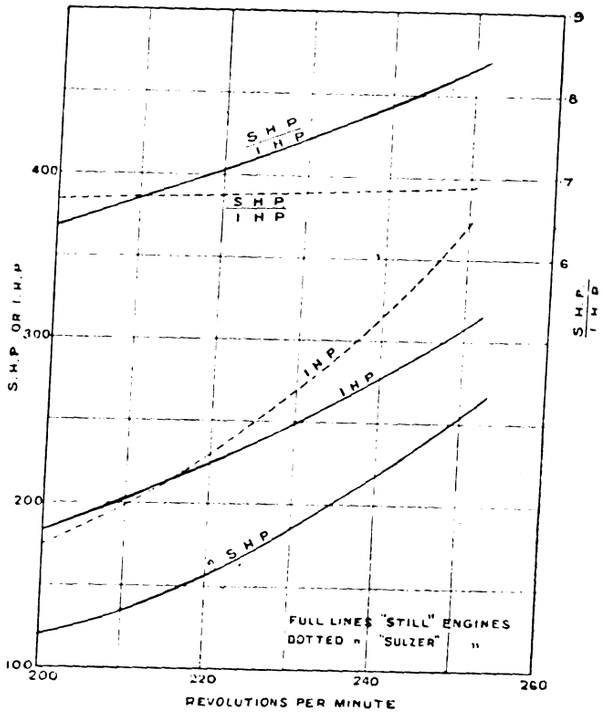

Fig. 5.—Horsepower Curves

A small boiler is part of the installation, from which the steam generated by burning oil in the boiler in the usual way is employed as the starting agent for the engine. The boiler also acts as a receiver for the steam derived from the waste heat of the exhaust gases of the internal combustion part of the engine. The feed water is circulated by a pump drawing from the bottom of the boiler and discharging through the tubes of a generator, which is heated by the exhaust gases of the engine passing round the tubes; from thence the water passes to the cylinder jackets of the engine, where it is used as the cooling agent, thus gaining more heat, and thereafter returns to the boiler in the form of steam and water. The steam thus generated is used in the steam end of the cylinder and adds to the power of the engine as a whole. The exhaust gases pass to the atmosphere on leaving the generator.

When the engine is running normally, i. e., under "waste heat" conditions, no fuel is burned in the boiler, the steam available being generated solely from the heat in the exhaust gases and from the heat transferred through the cylinder liner to the jacket water.

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The engine may be run at a considerable overload by augmenting the supply of steam through burning fuel in the boiler.

Owing to the high temperature of the cylinder jacket cooling water (i. e., boiler water), the compression pressure in the cylinder necessary for the ignition of the fuel is considerably lower than is the case in ordinary Diesel engine practice.

The cycle of the steam portion of the engine is just as in ordinary steam practice, an air and circulating pump, condenser, boiler feed pump, etc., forming part of the installation.*

The Sulzer engines in question have cylinders approximately 8½ inches diameter by 13¾ inches stroke, four cylinders to each engine; and are of the two cycle type. The Still engines have also four cylinders per set, 7¼ inches diameter and 15 inches stroke, fitted with a boiler of the Yarrow type; they are of the opposed piston type and two cycle.

The Still engines were designed with a view to their powers of maneuvering being beyond question. It was suggested that a separate high pressure cylinder might be fitted, the other cylinders being the second unit of the ordinary compound engine. By this means some economy might have been effected, but this complication was decided against. It may be added, while it has nothing to do with the question of relative economy of the engines, that the Still engines were arranged to run astern under steam only. Owing to this, the boiler was larger than would be necessary in an engine arranged for astern working with oil also.

The Sulzer engines, on the other hand, were made to the patentee's design of 1913. Improvements have been made since then, and it is possible that some of these improvements may tend towards greater economy.

It will be observed that the Sulzer engine cylinder capacity is considerably larger than that of the Still engine, which has an effect on the varying relative consumptions at the different numbers of revolutions.

In the Still engine the maximum revolutions without overloading and without the use of oil in boiler were about 240.

A representative of each patentee was present at the trials of his own system and was satisfied that the trials had been carried out in an approved manner. The trials were continued until these representatives were unable to suggest any modifications where better results might be obtained.

The oil used on the trials was shale 0.85 specific gravity.

The maneuvering of both types of engines was quite satisfactory. From ahead to astern the time was about five seconds, and in this respect the Still engine had a slight advantage.

During the trials, as shown on Fig. 4, the Still engine worked entirely under waste heat conditions, i. e., no oil was burned in the boiler.

It had been suggested that, in the case of the Still engine, oil from the cylinders might find its way to the boiler and have a dangerous effect on it. With this possibility in view, the boiler was frequently examined during the trials with the Still engine, and also at their termination, and there was practically no oil deposit found. On the other hand, the feed water filters required frequent attention. The generators remained clean throughout the trials.

The Sulzer engines were entirely constructed by the firm of William Denny & Brothers, but in the manufacture of the Still engines, owing to pressure of work in their own establishment, the assistance and co-operation of Messrs. T. A. Savery & Company, Ltd., Birmingham, was arranged for.

In carrying out the trials the principal aim was to ascertain accurately the oil used in terms of the speed of the vessel, being the point of view most likely to appeal to the shipowner.

The following illustrations are shown: Fig. 1, Sulzer engine; indicator cards. Fig. 2, Still engine, oil and steam; indicator cards. Fig. 3, thermal efficiency (approximate). Fig. 4, oil consumption in terms of revolutions (or speed). Fig. 5, indicated horsepower and shaft horsepower in terms of revolutions.

The shaft horsepower was taken by torsionmeter. The facilities for fitting this gear were limited, and the results must be regarded as approximate.

The thermal efficiency also is only to be regarded as approximate, as the exact calorific value of the fuel oil was not available; it was assumed to be 19,000 British thermal units.

The total weight of the Sulzer installation is 25 tons, and of the Still installation, with its special accessories and boiler, 29 tons; but, as previously stated, the boiler was larger than would have been necessary if the engines had been designed to work astern under oil.

* As the experimental engines in question were started and maneuvered astern under steam, and as in this case the solid oil injection principle was adopted, no storage of compressed air nor compressor were necessary or were provided.

European Motorship Building

BY OUR SPECIAL LONDON CORRESPONDENT

NEARLY all the British shipbuilders who have recently decided to enter upon marine Diesel engine manufacture have acquired licenses from firms which have already gained a good deal of experience, and it is indeed very unusual at the present time for any concern to start oil engine manufacture from entirely original designs. One of the exceptions to this rule is the North British Diesel Engine Works, Ltd., which has established a large new factory on the Clyde solely for building engines for motorships, and the first sets which have been constructed ran their shop trials in September.

Confidence Shown in New Design of Diesel Engine

The results are being awaited with the greatest interest in shipbuilding and engineering circles in the United Kingdom, for, although none of these engines has yet been put into operation, one of the leading British shipping firms, The British India Steam Navigation Company, has such confidence in the design that it has ordered six large motors for installation in three 11,000-ton motor cargo and passenger vessels which are now being built on the Clyde. In addition, the Union Steamship Company, of New Zealand, has contracted for two further sets, while a similar engine is to be installed in an existing tank steamer and two small ships are to be equipped with twin screw plants of the same type but of lower power. This confidence in an entirely new design is a matter of considerable interest and appears to point to the fact that it is possible to start Diesel engine manufacture and make it a profitable undertaking without having to pass through a long period of costly experimental work.

The new engine is of the four cycle type, and the majority of the sets being built develop 2,300 indicated horsepower each in eight cylinders of 26 inches diameter with a stroke of 47 inches. As the motor runs at the low speed of 96 revolutions per minute, it is necessarily somewhat heavy and of considerable height. The construction is unusual in many respects, and an entirely new reversing

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system has been adopted. The engine is divided into two sets of four separate cylinders, each set being carried on an entablature, which is itself supported by steel bolts extending down to the bottom of the bedplate. There are also cast iron columns, but these are comparatively light and narrow, and take none of the load, while plates fixed between them enclose the whole of the engine, as forced lubrication is used throughout.

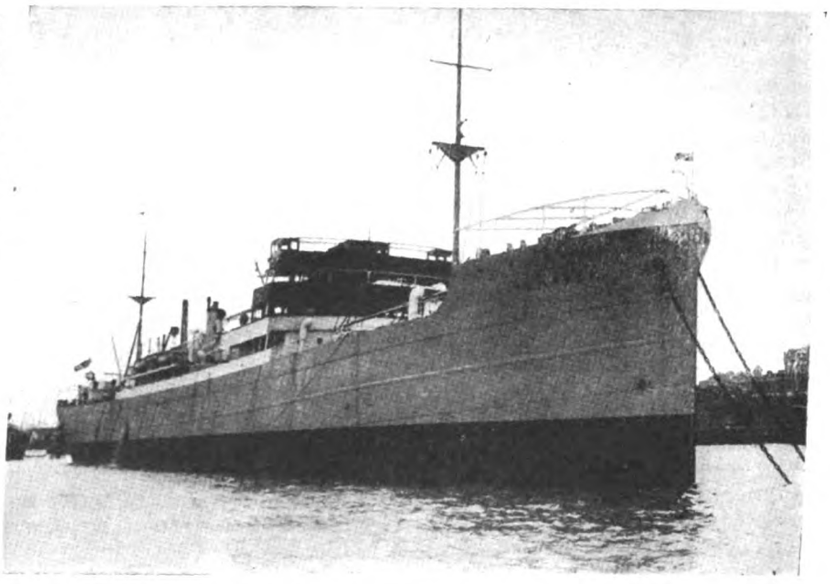

Fig. 2.—The New 9,400-Ton Motorship *Elmaren* Recently Completed by Götaverken at Gothenburg, Sweden, for the Transatlantic Steamship Company, Gothenburg

Novel Reversing System Adopted

The principle of the reversing system is to provide two side by side cams on the camshaft for the operation of each valve—exhaust, inlet, fuel and starting air—and to move the camshaft fore and aft on reversing. The main novelty lies in arranging for taking the rollers (attached to the short vertical push rods operating the valves) out of contact with the cams before the camshaft is shifted. This is effected by lowering the camshaft bodily by means of a rack and pinion operated from the normal type of reversing air engine. The usual method is to provide some device to lift the levers or rollers themselves, the camshaft remaining stationary, so that it will be seen that the ordinary arrangement is exactly reversed. Sea water is used for piston cooling, which is by no means general, as there is a tendency among European builders to employ fresh water for this purpose, and there are many other interesting points of which details will be given after the trial results have become available.

Motorship Building in Germany

It has already been mentioned that there are signs of awakening activity in oil engine building in Germany, and it is particularly interesting to learn that Blohm and Voss, of Hamburg, the builders of the double acting engined ship *Fritz* (now being run by the British Glen Line), are constructing double acting two cycle engines to the same design of much larger size. They are thus apparently satisfied that this is the right type, and it will be interesting to note whether any other European firms will follow suit. The A. E. G.-Hamburg-American Line combination, which established a works near Hamburg to build motorships equipped with opposed piston Diesel engines, has now given up this design and will manufacture the ordinary four cycle Burmeister and Wain type under license from the Danish firm. In view of these developments, it would not be entirely surprising to see Germany take a prominent place in motorship building construction within the course of the next few years.

Motorships of 18,000 Tons

One of the most important orders that has recently been placed for motorships is that which has just been settled in Copenhagen by the East Asiatic Company. This company has contracted for three cargo carrying motorships, the dimensions of which are not yet definitely settled. The ships will, however, carry approximately 18,000 tons of cargo at a speed of 11½ to 12 knots and will be built, like the majority of the other motor vessels for the same firm, by Burmeister and Wain at Copenhagen. The total machinery power will be in the neighborhood of 8,000 or 9,000 horsepower, and either a triple or quadruple screw arrangement will be adopted. It is probable that the former will be chosen and that three 8-cylinder engines of about 3,000 horsepower will be installed in this ship, similar in general type and construction to the two engines of the same power being fitted in the standard 14,000-

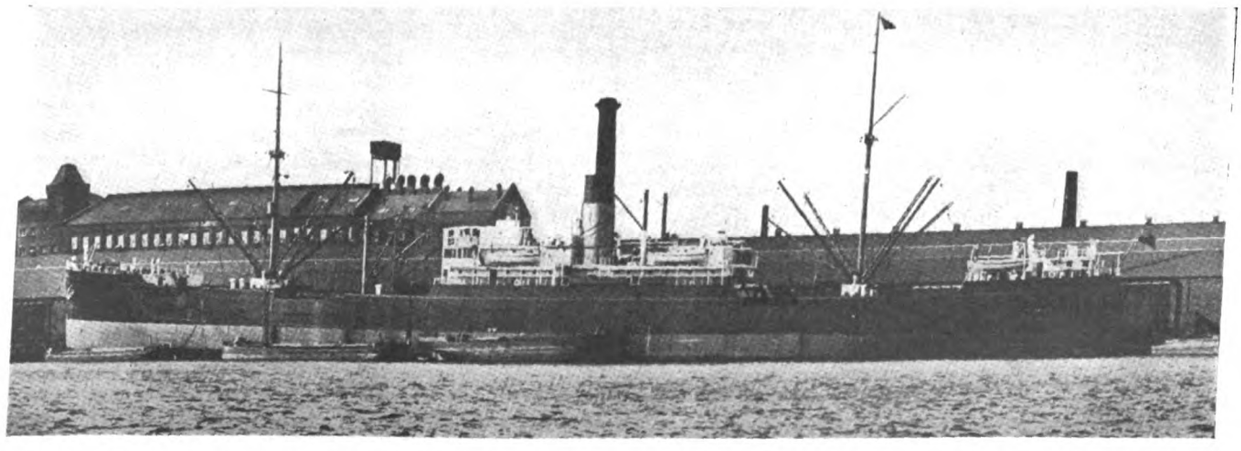

Fig. 1.—The 12,000-Ton Bibby Motorship *Dorsetshire* Fitted With 4,500 Horsepower Machinery, Ready for Her Maiden Voyage

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ton motorships which are now being built for the Glen Line.

The East Asiatic Company has progressively increased the size of its motorships, starting with the 8,000-ton *Selandia* in 1912, while the last ship completed was the *Afrika*, of 14,000 tons, equipped with two 2,250-horsepower motors. One of the main reasons for the gradual increase in size is that owners of motorships consider them to be especially suited for long voyages and for carrying a large amount of cargo at a reasonably high speed. The internal combustion engine ship shows to special advantage in this direction, owing to its economy in fuel, for the 18,000-ton ship mentioned will consume only about 27 tons of oil per day, which is no more than is required for an oil burning steamer carrying 10,000 tons at 10½ or 11 knots.

Although they have hitherto not interested themselves greatly in motorship construction, Messrs. Armstrong, Whitworth and Company have now decided to enter energetically into this new field and are building their first motor vessel for Spanish owners. She is a 6,500-ton craft, 390 feet in length, with a designed speed of 11½ knots. The machinery installation, which will be built by Armstrongs in conjunction with Sulzers under license from the Swiss firm, comprises a couple of four cylinder, 1,250 brake horsepower, two cycle motors of the ordinary Sulzer design, running at 100 revolutions per minute and having cylinders 600 millimeters diameter and 930 millimeters stroke. It is probable that the Armstrong's decision in this connection has been brought about by the immense activities which are now being shown by two of the largest shipbuilding concerns in the United Kingdom, namely, Vickers and Harland & Wolff.

Relative Power and Space Occupied By Various Types of Diesel Engines*

BY ENGINEER-COMMANDER C. J. HAWKES, R. N. (RET.)

COMPARISONS have frequently been made between Diesel engines of various types in regard to power and space occupied, but in many cases such comparisons have either been based on assumptions which could not be wholly accepted or certain assumptions have been taken no doubt with the object of emphasizing the advantages of a particular engine. A short time ago the author had occasion to look into this question with the object of ascertaining the approximate brake horsepower which could be developed by high duty Diesel engines of the four stroke single acting, two stroke single acting, and two stroke double acting types, designed for the same overall length and height. The engines considered were based on laboratory designs. It is not possible in this paper to give in detail the whole of the assumptions made, but the principal points assumed were:

(1) Air injection in all cases.
(2) The compressor and scavenge pumps driven from the main engines.
(3) Separate guides in the case of the two stroke engines and trunk pistons only in the case of the four stroke engines.

Taking the power developed by the eight cylinder four stroke engine as the unit, the comparative figures obtained are shown in Table I:

TABLE I

Type of Engine	Number of Cylinders	Comparative Figure for Brake Horsepower (8-Cylinder, 4-Stroke Engine Taken as Unity)
Four-stroke, single acting.....	8	1
Four-stroke, single acting.....	6	1.22
Two-stroke, single acting.....	6	1.44
Two-stroke, single acting.....	8	1.38
Two-stroke, double acting.....	6	1.9

With the assumptions taken it will be seen that it is advantageous to keep down the number of cylinders in an engine; also, the increase of power resulting from the adoption of the two stroke single acting engine is not very marked. There is a distinct advantage in favor of the two stroke double acting engine, but it would be more complicated and its use could only be justified for higher powers than those at present contemplated.

Although the comparative figures arrived at are correct for the assumptions taken, other points, in addition to space occupied, have to be considered when deciding on the type of engine to be used for powers larger than those at present in use or under construction. The advantages and disadvantages of the various types are well known and need not be discussed in this instance. For powers of the order of 2,000 brake horsepower per engine for high speed naval work there would be no great difference in the widths of the three types of engines, but as the power increased it is probable that the width of the four stroke engine would be slightly greater than the widths of the two stroke engines—at least so far as the six cylinder engine is concerned. This would necessitate a wider engine room in order to accommodate pistons and covers when dismantling.

It has been assumed in these comparisons that the four-stroke engines are not fitted with separate crossheads, as in the case of the two stroke engines. If separate crossheads were fitted, it would be necessary to reduce the stroke of the engine for a given headroom, so that either the piston speed would have to be reduced, or, if the piston speed were maintained, the inertia forces would be increased. This, in addition to the size of the cylinder, etc., would probably limit the use of four cycle engines for comparatively high powers.

Other assumptions in regard to the method of driving the scavenge pumps, number of cylinders per engine, etc., could be taken in order to arrive at comparative figures for brake horsepowers solely from the point of view of space occupied, but it is considered that the cases worked out give a good idea of what may be generally expected. It is clear from the results given that, compared with the four stroke engine, the increase in power obtained by the adoption of the two stroke single acting or two stroke double acting engine is not so great as is frequently stated.

Although, from the point of view of actual performance under seagoing conditions, the four stroke engine has proved more reliable than the two stroke engine for submarine propulsion, the possibilities of the latter cannot be overlooked. The four stroke engine was the first in the field and has received more attention, but the two stroke engine is the natural line of development, and it may prove of considerable value should greater powers be required in the future than those at present contemplated.

A low fuel consumption is, of course, desirable, but other factors, e. g., weight and space, are also of great importance where naval engines are concerned. If, therefore, the two stroke engine is developed so that there are no doubts as to its reliability, it is considered that it will prove a serious competitor to the four stroke engine, even for moderate powers, for it can be made a more simple engine so far as the vital parts are concerned.

* From a paper on "Some Experimental Work in Connection with Diesel Engines," read at the summer meetings of the Institution of Naval Architects, Liverpool, England, July 8, 1920.

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Cargo Motorships vs. Steamships—II

Fixed Annual Expenses and Service Expenses—Cost of Cargo Transportation, Net Earnings and Investment Returns

BY CHARLES E. LUCKE*

ALL earnings are derived from cargo handled and are to be estimated from the cargo capacities per Table 7 by applying an assumed freight rate. Freight rates are necessarily variable, so estimates of earnings must be also variable, especially as rates on return cargoes may be different than for outbound or no return cargoes obtainable. Figures are available on rates, ranging from $.75 to $3.50 per 1,000 ton-miles and showing a difference of 50 percent between outbound and return rates. As world trade conditions change, so must these rates change, so any estimate made may be entirely wrong shortly afterward.

For the purpose of indicating form of procedure, a rate of $3.50 per 1,000 ton-mile will be applied to the New York to Liverpool route, or 3.220 × 3.50 = $11 in round numbers per ton one way but applying to both directions. For the New York to Buenos Aires route $2.50 per 1,000 ton-miles, or 5.870 × 2.50 = $15 per ton, and New York to South Africa $3 per 1,000 ton-miles, or $3 × 8.000 = $24 per ton. The earnings are calculated on deadweight cargo capacity in Table 7 using these freight rates. A similar calculation can be made on the basis of bulk or measurement cargo, but this is omitted to avoid confusion due to two sets of figures.

TABLE 7.—GROSS EARNINGS ON DEADWEIGHT CARGO

Voyage	Item	Steamship Per Voyage	Steamship Per Year	Motorship Per Voyage	Motorship Per Year
New York to Liverpool and return; rate, $11.00 per ton; 5.3 voyages per year	Cargo tons...	17,680	93,704	19,030	100,859
	Earnings	$194,480	$1,030,744	$209,330	$1,109,449
New York to Buenos Aires and return; rate, $15.00 per ton; 4.1 voyages per year	Cargo tons...	16,120	66,092	18,450	75,645
	Earnings	$241,800	$991,380	$276,750	$1,134,675
New York to South Africa and return; rate, $24.00 per ton; 3.4 voyages per year	Cargo tons...	14,890	50,666	18,030	61,302
	Earnings	$357,360	$1,215,984	$432,720	$1,471,248

Expenses

Expenses are made up of items that may be classified as fixed charges and operating charges, but a better division is that in which all expenses of annual nature, independent of the cargo handled or number of voyages, are grouped together as *fixed annual expenses*, and all other items combined in another group as *service expenses*.

Fixed annual expenses include interest, depreciation (including obsolescence), maintenance, loss and damage, crew wages and subsistence, water and stores. *Service expenses* include fuel, cargo handling, insurance and port charges.

Interest, Depreciation and Obsolescence

Interest, depreciation and obsolescence can be treated as one item—the investment charges fixed by a definite annual percent of the first cost of the ship. Such a motorship as is here considered is valued at $1,950,000 and the steamship at $1,800,000. Values for the rate to be applied to the investment differ widely, some figures being as high as 10 percent for depreciation and obsolescence and 6 percent interest, but usually the high figures are based upon an assumption of short life of machinery, or on a desire to write off on the books the value of the ship as soon as possible as a matter of accounting policy.

Basing a figure on the estimated life of the ship taken at twenty years and carrying the account for the full time, it is possible to charge interest at 6 percent on the decreasing book value and to depreciate or obsolesce the investment at 2 percent for the first year; thus, keeping a constant total of 8 percent per year, write off the account in twenty years. On this basis, the annual investment charge is .08 × $1,800,000 = $144,000 for the steamship and .08 × $1,950,000 = $156,000 for the motorship, leaving a difference of $12,000 against the motorship.

Maintenance

Maintenance includes both material and labor required for the upkeep of the ship and machinery over what the regular crew can accomplish. Considerable information is available on the maintenance cost for steam vessels with Scotch boilers and reciprocating engines, indicating that a fair figure for a 10,000-ton ship would be close to $10,000 per year for machinery, a considerable part being chargeable to boilers, and at pre-war rates. Simliar information collected from motorship owners indicates that a correspondingly fair figure for Diesel machinery of modern design would be about $8,000 per year. Very little information is available for geared turbine steamers, but it seems fair to assume that the upkeep cost would be less than for reciprocating engines. In view of the fact that most of the expense is due to boilers, it seems that the fair proportionate figure would be $8,000 for the geared turbine against the $10,000 for reciprocating engine.

These figures indicate that the maintenance of the machinery of the motorship and geared turbine steamship with Scotch boilers is about the same, and about $8,000 per year at pre-war rates, or $20,000 at present prices of supplies, wages of shipyard and machinery, labor and present output per man. To this this must be added maintenance charges for the ship, fittings and deck gear, which, it is assumed, will bring the total to $50,000 per year for both ships, or $5 per deadweight ton per year.

Crew wages and subsistence charges are based on assumed complement and rate of wages, with allowances of $1 per day per man for subsistence. The crew is divided into three groups: (a) deck, (b) steward, these two being the same for steamship and motorship, and (c) engine, in which there are some differences. A careful study of the situation has led to the adoption of Table 8 for the engine crew for the 10,000-ton vessels under construction.

These men make up three watches and a day working party, each of which has the following complement:

Group	Steamship	Motorship
Watch	1 senior engineer in engine room 1 oiler in engine room 1 wiper in engine room 1 water tender in boiler room 1 fireman in boiler room	1 senior engineer 1 junior engineer 1 oiler
Day Working Party	1 deck engineer	1 deck engineer 1 junior engineer 1 oiler

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TABLE 8.—ENGINE CREW WAGES AND SUBSISTENCE

Position or Title	Wages per Man	Steamship Number	Steamship Wages per Month	Motorship Number	Motorship Wages per Month
Chief engineer	$346.25	1	$346.25	1	$346.25
First	235.00	1	235.00	1	235.00
Second	206.00	1	206.00	1	206.00
Third	182.50	1	182.50	1	182.50
Deck	182.50	1	182.50	1	182.50
Junior	150.00	..	.....	4	600.00
Oilers	95.00	3	285.00	4	380.00
Wipers	90.00	3	270.00	..	.....
Water tenders	95.00	3	285.00	..	.....
Firemen	90.00	3	270.00	..	.....
Total	$1,772.25	17	$2,262.25	18	$2,132.25

The steamship monthly wages for engine crew of $2,262.25 is equivalent to 12 × 2,262.25 = $27,147 per year, to which must be added subsistence for 17 men at $1 per day, or 17 × 365 = $6,205, making the total $27,147 + $6,205 = $33,352 per year.

For the motorship the year wages are 12 × 2,132.25 = $25,587, to which add subsistence 13 × 365 = $4,745, making the total $25,587 + $4,745 = $30,332 per year.

Not only is there a difference in crew cost in favor of the motorship, but the most troublesome class of labor is eliminated—the coal passers and firemen—and the smaller motorship crew of higher class men is very much easier for the chief engineer to manage.

To provide suitable men for this new service, Worthington is prepared to train men with suitable experience in its shops where the engines are tested complete before installation in ships.

Deck and steward complements are not analyzed in detail here, but are estimated at 16 men in the deck and 10 men in the stewards' departments, a total of 26 men. These men will receive in wages $33,688, to which add subsistence of 26 × 365 = $9,490, making the total $43,178. This, when added to the total for the engine crew, makes the grand total of yearly crew expense $33,352 + $43,178 = $76,530 for the steamship, and $30,332 + $43,178 = $73,512 for the motorship.

Stores

Stores, exclusive of those covered by subsistence, are estimated on the quantity of one ton per day used in analyzing deadweight, and are priced at the average figure of $65 per ton for all three departments, engine, deck and steward, and the same for both types of ships. This adds to the annual expense a total of 365 × 65 = $23,725.

Loss and Damage

Loss and damage estimates seem to be pure guesses, and figures have been called to our attention ranging from $5 to nearly $20 per day for ships of 10,000 tons, but varying somewhat with freight rates, routes, port conditions and amount of cargo. It is, at any rate, quite the same for the two types of ships, so that any reasonable estimate can be regarded as proper within the scope of such a comparison as this, and it is, furthermore, quite a small item. As time is certainly a factor, the rate assumed is based on days and the figure taken as $10 per day for both ships. On this basis the item becomes an annual charge of $3,650 per year against each ship.

Water Expense

Water expense based on the crew consumption of about 20 gallons per day per man and about 2 percent of the boiler evaporation as make-up for the steamer would be a service charge, were it not for the fact that the steamship port water losses are substantially the same as at sea. It may, therefore, be assumed that both ships will use water continuously at the rates of Table 3, which are 13 tons per day for the steamship and 3 tons per day for the motorship. The rate to be charged for the water is based on that for water purchased at New York City—$1 per 1,000 cubic feet, which in round numbers is 3 cents per long ton. This makes the daily costs $4 for the steamer and $1 for the motorship.

Accordingly, the annual water charge for the steamship is 4 × 365 = $1,460, and for the motorship $365.

Fixed annual expenses in the aggregate are summarized in Table 9:

TABLE 9.—FIXED ANNUAL EXPENSE

Item	Steamship	Motorship
Investment charge	$144,000	$156,000
Maintenance	50,000	50,000
Crew wages and subsistence	76,530	73,512
Stores	23,725	23,725
Loss and damage	3,650	3,650
Water	1,460	365
Total	$299,365	$307,252

Service Expenses

Service expenses all vary with the number and length of voyages, and include the items of fuel, cargo, handling, insurance and port charges. Each expense item can be estimated only on an assumed price or rate, and these are subject to natural trade fluctuations, so that any overall result must be checked before using it as a basis of commercial conclusion by applying new prices and rates prevailing at the time and place under consideration.

Fuel Expense

Fuel expense is partly a matter of fuel consumption determined in Table 5, but quite as much a matter of fuel price. Fuel oil prices are very uncertain, differing not only in different ports for the same grade of oil and with appreciable differences appropriate to grades (the lighter being higher in price), but at any one place prices fluctuate from day to day. About the only stable element of oil prices is the general upward trend that has prevailed for several years and which, according to present indications, will continue at least for the near future.

The range of variation in prices in different world ports for one set of figures for 1919 was from $.80 per barrel minimum at Gulfport to $10 per barrel maximum at a China port, and the bulk of the figures are between $1 and $4 per barrel. As it is necessary to adopt a price to complete the estimate of expenses of operation, a round figure of $3 per barrel is selected as a fair value for the present and immediate future for 16-degree Baumé oil for the steamship boilers and $3.50 for 22-degree Baumé oil for the motorship engines, retaining the usual excess over the former, which is about 15 percent. These prices correspond to $3 × 6.67 = $20.01 per ton for 16-degree Baumé oil, and $3.50 × 6.95 = $24.32 per ton for 22-degree Baumé oil. On these figures the fuel expense per trip and per year is worked out as in Table 10 for three typical voyages:

TABLE 10.—FUEL OIL EXPENSE

Voyage		Steamship—Oil at $3.00 Barrel 16 Degrees Baumé Trip	Steamship Year	Motorship—Oil at $3.50 Barrel 22 Degrees Baumé Trip	Motorship Year
New York to Liverpool and return, 6,439 miles; 5.3 voyages per year	Oil required, tons.	1,051	5,570	342	1,813
	Fuel expense	$21,030	$111,459	$8,317	$44,080
New York to Buenos Aires and return, 11,740 miles; 4.1 voyages per year	Oil required, tons.	1,741	7,138	602	2,468
	Fuel expense	$34,837	$142,831	$14,641	$60,027
New York to South Africa and return, 16,000 miles; 3.4 voyages per year	Oil required, tons.	2,298	7,813	810	2,754
	Fuel expense	$45,983	$156,342	$19,699	$66,977

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It will be noted that the very much lower fuel consumption of the motorship is responsible for a big margin of difference in fuel expense, even if the more expensive grade of fuel is selected as a matter of convenience. Thus, for the shortest of the three voyages, that to Liverpool, there is a saving of $67,500 per year by the motorship against the steamship expense of $111,500; for the medium voyage, that to Buenos Aires, the motorship saves over $83,000 per year against the steamship expense of over $143,000 per year. These substantial savings overbalance all the excesses of fixed annual charges by very considerable margins and are the main factors in the general overall commercially economic superiority of the motorship. Of course, the lower fuel prices will reduce this margin, but will not eliminate it until fuel prices are lower than they will ever be, except possibly at the producing points, or materially less than $1 per barrel.

CARGO HANDLING

Cargo handling expense is to be based on an estimated rate per ton handled, each ton being handled twice—once in loading and again discharging at another port, so the rate must be the average for all ports. While the rate will be determined in specific cases by handling facilities, labor wage rates and efficiency of the labor, it is sufficient for present purposes to take a flat fixed rate of $2 per ton, as the rate will be the same for both ships and will not materially affect the comparison of the types. On this basis the figures of Table 11 were computed from the figures on total cargo from Table 6:

TABLE 11.—CARGO (DEADWEIGHT) LOADING AND DISCHARGING EXPENSE

Voyage	Item	Steamship Voyage	Steamship Year	Motorship Voyage	Motorship Year
New York to Liverpool	Cargo handled, tons	17,680	93,704	19,030	100,859
	Expense	$35,360	$187,408	$38,060	$201,718
New York to Buenos Aires	Cargo handled, tons	16,120	66,092	18,450	75,645
	Expense	$32,240	$132,184	$36,900	$151,290
New York to South Africa	Cargo handled, tons	14,990	50,966	18,030	61,362
	Expense	$29,980	$101,932	$36,060	$122,604

INSURANCE

Insurance is based on ship valuation, and the rates per voyage depend on the voyage, which, of course, are variable, depending partly on hazard and partly on commercial conditions. Omitting such special risks as war and piracy, the rates used in Table 12 are reasonable possibilities and about in correct relative proportion:

TABLE 12.—INSURANCE EXPENSE

Voyages	Item	Steamship $1,800,000 Trip	Steamship $1,800,000 Year	Motorship $1,950,000 Trip	Motorship $1,950,000 Year
New York to Liverpool and return; rate, ½ percent; 5.3 voyages per year; 67 days	Insurance	$9,000	$47,700	$9,750	$51,675
New York to Buenos Aires and return; rate, 1 percent; 4.1 voyages per year; 87 days	Insurance	$18,000	$73,800	$19,500	$79,950
New York to South Africa and return; rate, 1½ percent; 3.4 voyages per year; 104 days	Insurance	$27,000	$91,800	$29,250	$99,500

Port charges, including wharfage and pilotage, are specific items for each port, depending on local conditions there, and are, of course, the same for both types of ship. The figures of Table 13 are believed to be fair estimates:

TABLE 13.—PORT CHARGES, WHARFAGE AND PILOTAGE EXPENSE

Voyage	Steamship Voyage	Steamship Year	Motorship Voyage	Motorship Year
New York to Liverpool, 5.3 trips per year	$8,000	$42,400	$8,000	$42,400
New York to Buenos Aires, 4.1 trips per year	6,000	24,600	6,000	24,600
New York to South Africa, 3.4 trips per year	9,000	30,600	9,000	30,600

Service expenses are obtained in Table 14 by adding all the separate items for each voyage:

TABLE 14.—SERVICE EXPENSE

Voyage	Item	Steamship Voyage	Steamship Year	Motorship Voyage	Motorship Year
New York to Liverpool and return	Fuel	$21,030	$111,459	$ 8,317	$ 44,080
	Cargo handling	35,360	187,408	38,060	201,718
	Insurance	9,000	47,700	9,750	51,675
	Port charges	8,000	42,400	8,000	42,400
	Total	$73,390	$388,967	$64,127	$339,873
New York to Buenos Aires and return	Fuel	$34,837	$142,831	$14,641	$ 60,027
	Cargo handling	32,240	132,184	36,900	151,290
	Insurance	18,000	73,800	19,500	79,950
	Port charges	6,000	24,600	6,000	24,600
	Total	$91,077	$373,415	$77,041	$315,867
New York to South Africa and return	Fuel	$45,983	$156,342	$19,699	$ 66,977
	Cargo handling	29,780	101,332	36,060	122,604
	Insurance	27,000	91,800	29,250	99,500
	Port charges	9,000	30,600	9,000	30,600
	Total	$111,763	$380,074	$94,009	$319,681

Total expense of all kinds is summarized in Table 15 by adding together the totals of fixed annual expense, Table 9, and those of service expense, Table 14:

TABLE 15.—TOTAL EXPENSE

Voyage	Item	Steamship Voyage	Steamship Year	Motorship Voyage	Motorship Year
New York to Liverpool and return: 5.3 voyages per year	Fixed annual	$56,484	$299,365	$57,972	$307,252
	Service	73,390	388,967	64,127	339,873
	Total	$129,874	$688,332	$122,099	$647,125
New York to Buenos Aires and return: 4.1 voyages per year	Fixed annual	$73,017	$299,365	$74,939	$307,252
	Service	91,077	373,415	77,041	315,867
	Total	$164,083	$672,780	$151,980	$623,119
New York to South Africa and return: 3.4 voyages per year	Fixed annual	$ 88,048	$299,365	$90,368	$307,252
	Service	111,763	380,074	94,009	319,681
	Total	$199,811	$679,439	$184,377	$626,933

4. COST OF CARGO TRANSPORTATION, NET EARNINGS AND INVESTMENT RETURNS

By bringing together the items of cargo handled in Table 6 and the total expenses incurred in Table 15, the transportation costs can be determined, and this is done in Table 16:

TABLE 16.—COST OF TRANSPORTATION OF CARGO (DEADWEIGHT)

Voyage	Item	Steamship Voyage	Steamship Year	Motorship Voyage	Motorship Year
New York to Liverpool and return, 6,439 miles	Cargo, tons	17,680	93,704	19,030	100,859
	Cargo 1,000 ton-miles				
	Total expense	$129,874	$688,332	$122,099	$647,125
	Cost per ton	$7.34		$6.42	
	Cost per 1,000 ton-mile	1.14		1.00	
New York to Buenos Aires and return, 11,740 miles	Cargo, tons	16,120	66,092	18,450	75,645
	Cargo 1,000 ton-miles				
	Total expense	$164,083	$672,780	$151,980	$623,119
	Cost per ton	$10.17		$8.23	
	Cost per 1,000 ton-mile	0.87		0.70	
New York to South Africa, 16,000 miles	Cargo, tons	14,890	50,666	18,030	61,362
	Cargo 1,000 ton-miles				
	Total expense	$199,811	$679,439	$184,377	$626,993
	Cost per ton	$13.42		$10.23	
	Cost per 1,000 ton-mile	0.84		0.64	

These costs per ton per voyage when compared with the freight rates of $11 per ton to Liverpool, $15 per ton to Buenos Aires and $24 per ton to South Africa indicate a good margin of profit even if the rates were consider-

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ably reduced. In all cases, also, the motorship costs per ton-mile are appreciably lower by about 14 percent, 20 percent and 22 percent in the three cases, which is an increasing percent for the longer trip and smaller costs.

Net earnings and investment returns are summarized in Table 17, the figures for gross earnings being transferred from Table 7, those for total expense from Table 15, and the difference in net earnings per year computed in terms of percent return on the investment.

TABLE 17.—NET EARNINGS AND INVESTMENT RETURNS

Voyage	Item	Steamship $1,800,000 Valuation Voyage	Steamship $1,800,000 Valuation Year	Motorship $1,950,000 Valuation Voyage	Motorship $1,950,000 Valuation Year
New York to Liverpool and return; 5.3 voyages per year	Gross earnings	$194,480	$1,030,744	$209,330	$1,109,449
	Total expense.	129,874	688,332	122,099	647,125
	Net earnings..	$64,606	$342,412	$87,231	$462,324
	Investment returns, percent per year.....	19.0		23.8	
New York to Buenos Aires and return; 4.1 voyages per year	Gross earnings	$241,800	$991,380	$276,750	$1,134,675
	Total expense.	164,083	672,780	151,980	623,114
	Net earnings..	$77,717	$318,600	$124,770	$511,561
	Investment returns, percent per year.....	17.70		26.25	
New York to South Africa and return; 3.5 voyages per year	Gross earnings	$357,360	$1,215,984	$432,720	$1,471,248
	Total expense.	199,811	679,439	184,377	626,993
	Net earnings..	$157,549	$536,545	$248,343	$844,255
	Investment returns, percent per year.....	29.80		43.32	

These figures of net return on investment are all favorable to the motorship, and more so as the length of the voyage is greater. Comparing the net returns directly, the motorship yield is for the three voyages—Liverpool, Buenos Aires and South Africa—1.26, 1.48 and 1.45 times those for the steamship. These differences demonstrate clearly the necessity of such calculations as these to determine the most profitable routes for motorships as compared with steamships.

Another basis of comparison of some merit is the excess of net earnings of the motorship on the excess investment. This investment excess is $1,950,000 — $1,800,000 = $150,000. The excess of net yearly earnings of the motorship for the three typical voyages in order is $119,912, $192,961 and $307,710. These net yearly returns represent percent returns on the extra motorship investment of $150,000 of 82 percent, 129 percent and 205 percent respectively, showing a uniformly increased return on the investment excess on the whole amount for the three voyages studied and increasing with length of voyage. Attention is again called to the case of bulk cargo, in which results are also favorable to the motorship, but omitted for the sake of greater clearness.

These comparative calculations for the operations of steamships and motorships are presented primarily to show that the motorship has decided advantages over the steamship on a purely commercial profit earning basis, when care is exercised in selecting suitable service conditions and a proper trade route. The selection of proper conditions and the decision as to the commercial value of a motorship over a steamer cannot be made in a haphazard manner, and general overall figures are apt to be misleading, to say the least. There is only one way known to get at the facts, and that is the preparation of a carefully itemized statement, with each separate factor as accurately determined as possible for the conditions to be met, and the object of the bulletin is to assist those interested by presenting these forms and tables.

An invitation is extended to all concerned to send in further data on any or all of these items that will contribute to improvement of future estimates, both as to volume of data for all sorts of conditions and the accuracy of the figures as derived from actual experience in ship operation.

APPENDIX

TABLE 18.—FUEL OIL SUPPLY STATIONS—PARTIAL LIST

1. Agna Santa Railroad Company.
   Peru—Callao.
2. American Petroleum Company.
   Holland—Amsterdam and Rotterdam.
3. Anglo-American Oil Company, Ltd.
   United Kingdom—Avonmouth, Barrow, Belfast, Birkenhead, Brixham, Dublin, Glasgow, Grangemouth, Hull, Liverpool, Manchester, Newcastle, Plymouth, Purfleet, Southampton, Sunderland.
   Africa—Cape Town, Bizerta.
   Argentine—Campana.
   Brazil—Rio Janeiro.
   Chile—Antofagasta, Iquique, Pisagua, Taltal, Tocopilla, Valparaiso.
   Peru—Callao, Payta, Talara.
   Uruguay—Montevideo.
   Canada—Halifax, Montreal, Prince Rupert, Vancouver.
   Denmark—Aalborg, Copenhagen, Odense.
   Italy—Genoa, Monopoli, Savona, Venice.
   Mexico—Tampico.
   Norway—Bergen, Christiania, Portici, Vallo.
   Panama Canal.
   Porto Rico—Ponce, San Juan.
   Sweden—Gothenburg, Stockholm.
   United States—Baltimore, Baton Rouge, Bayonne, N. J., Beaumont, New Orleans, New York, Norfolk, Va., Philadelphia, Port Arthur, Portland, Ore., Sabine, San Francisco, San Pedro, Seattle, Wash.
   Cuba—Cienfuegos, Havana, Matanzas.
   Dutch W. I.—Curacao.
   China—Hong Kong, Shanghai.
   Japan—Yokohama.
   Hawaii—Honolulu.
4. Anglo-Mexican Oil Corporation.
   England—Barton, Grimsby, Hull, Liverpool, London, Manchester, Thames Haven.
   Mexico—Puetro Mexico, Salina Cruz, Tampico, Tuxpan, Vera Cruz.
   Brazil—Bahia, Ponta de Coja, Nictheroy, Rio de Janeiro, Santos.
   Argentine—Buenos Aires.
   Uruguay—Montevideo.
   Virgin Islands—St. Thomas.
5. Anglo-Persian Oil Company.
   India—Bombay.
6. Anglo-Saxon Petroleum Company.
   Portugal—Lisbon.
7. Asiatic Petroleum Company.
   Portugal—Lisbon.
   Egypt—Alexandria, Port Said, Suez.
   Borneo—Balik Papan, Tarakan.
   Siam—Bangkok.
   Java—Batavia, Surabaya.
   India—Bombay, Calcutta, Cochin, Conconada, Tuticorin, Karachi, Madras, Rangoon.
   South Africa—Cape Town.
   Ceylon—Colombo.
   China—Hong Kong, Shanghai, Singapore.
   Canary Islands—Las Palmas.
   Japan—Nagasaki, Saitakaki.
   Sumatra—Palembang, Sabang.
   Australia—Sydney.
8. Associated Oil Company.
   Hawaii—Honolulu.
   United States—Portland, Ore., San Francisco, Cal.
9. British Imperial Oil Company.
   Australia—Adelaide, Melbourne, Sydney.
   South Africa—Cape Town.
   Holland—Rotterdam.
   Egypt—Suez.
10. British Petroleum Company.
    England—Avonmouth.
11. Belcher Asphalt Paving Company.
    United States—Miami, Fla.
12. Cairns, R.
    Scotland—Leith.
13. Caloric Company.
    Brazil—Hahia, Rio de Janeiro.
14. Curacao Petroleum Company.
    West Indies—Curacao.

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15. Det. Panske Petroleum Akt.
Norway—Bergen, Christiania.
Denmark—Copenhagen.
Sweden—Stockholm, Gothenburg.
16. Compania Mexican de Petrolio.
Mexico—Salina Cruz, Vera Cruz.
17. Duncan Fox & Company.
Chile—Antofagasta, Valparaiso.
18. Ferro Carril de Junin.
Chile—Junin.
19. Grace, W. R., & Company.
Peru—Callao.
Salvador—La Union.
20. General Petroleum Company.
United States—San Pedro, Cal.
21. Gulf Refining Company.
United States—Port Arthur, Texas.
22. Hoden Oil Company.
Japan—Niigata.
23. Imperial Oil Company, Ltd.
Canada—Halifax, N. S., Montreal, Prince Rupert, B. C., Vancouver, B. C., Victoria, B. C.
24. International Petroleum Corporation.
Chile—Antofagasta, Iquique, Pisagua, Taltal, Tocopilka, Valparaiso.
Peru—Callao, Paita, Talara.
25. Importazione Oil.
Italy—Palermo, Sicily.
26. Johnson, A., & Company.
Sweden—Gothenburg.
27. International Railways of Central America.
Guatemala—San Jose.
28. Lykes Brothers.
Cuba—Havana.
29. Magnolia Petroleum Company.
United States—Galveston, Tex.
30. Marnzen Mineral Oil Company.
Japan—Kobe.
31. Mexican Petroleum Corporation.
Brazil—Bahia, Tuxpan, Rio de Janeiro.
United States—Jacksonville, Fla.; Portland, Me.; Providence, R. I.; Tampa, Fla.
32. Mead, King, Robinson & Company, Ltd.
England—Barton, Liverpool.
33. Mitchell, Cotts & Company.
South Africa—Cape Town.
34. Mitsubishi Company.
Japan—Kobe.
35. Panama Railroad Company.
United States—Balboa, Canal Zone.
36. Pan-American Petroleum and Transportation Company.
United States—Boston, Mass.; Cristobal, Canal Zone.
37. Rising Sun Company.
Japan—Aomori.
38. Royal Dutch Shell Company.
Holland—Amsterdam, Rotterdam.
West Indies—Curacao.
China—Hong Kong.
39. Salaverry Agencies Company.
Peru—Salaverry.
40. Shell Oil Company of California.
United States—San Francisco, Cal.; San Pedro, Cal.
41. Sinclair Oil Company.
Cuba—Havana, Matanzas.
42. Societe pour L'Importation des Huiles de Graissage.
Belgium—Antwerp.
43. Societe Italie Am. Petroleum.
Tunis, Africa—Bizerta.
Italy—Genoa, Monopoli, Portici, Venice.
44. Societe des Petroles Au Congo.
Africa—Ango Ango, Boma, Belgian Congo.
45. Standard Oil Company.
United States—Aberdeen, Wash.; Baltimore, Md.; Baton Rouge, La.; Key West, Fla.; Portland, Ore.; San Diego, Cal.; San Francisco, Cal.; San Pedro, Cal.; Seattle, Wash.; Tacoma, Wash.; Tampa, Fla.
Egypt—Alexandria.
India—Bombay, Calcutta, Cochin.
Italy—Genoa.
Hawaii—Honolulu.
Alaska—Ketchikan.
Japan—Nagasaki.
Brazil—Rio de Janeiro.
Greece—Salonica.
Turkey—Smyrna.
Java—Somalaya.
Mexico, Tuxpam.
46. Standard Oil Company of Louisiana.
United States—New Orleans, La.
47. Standard Oil Company of New Jersey.
United States—New York City, Norfolk, Va.
48. Texas Oil Company.
United States—Providence, R. I.; New York City, Philadelphia, Baltimore, Md.; Norfolk, Va.; Charleston, S. C.; Savannah, Ga.; Jacksonville, Fla.; Key West, Tampa, New Orleans, Gulfport, Miss.; Port Arthur, Tex.; Galveston, Port Aransas, Tex.; Colon, C. Z.
Porto Rico—Ponce.
49. Trinidad Leaseholds, Ltd.
Trinidad—Port of Spain.
50. Union Oil Company.
Canada—Vancouver, B. C.
Hawaii—Honolulu.
Chile—Valparaiso, Iquique, Taltal.
United States—Portland, Ore.; Port San Luis, Cal.; San Diego, Cal.; San Francisco, Cal.; San Pedro, Cal.; Seattle, Wash.
51. United British Refineries.
Trinidad—Port of Spain.
52. Vestlandske Petr. Komaui.
Norway—Bergen, Christiania, Stavanger.
53—Vacuum Oil Company.
Australia—Melbourne.
Egypt—Port Said.
54. West India Oil Company.
Argentina—Bahia, Blanca, Buenos Aires, Campana.
Peru—Callao, Paita, Talara.
West Indies—Curacao.
Uruguay—Montevideo.
Chile—Pisaga, Valparaiso.
Porto Rico—Ponce, San Juan.
Bermuda—St. George.
55. White, J. G., & Company.
Nicaragua—Corinto.
Cuba—Havana, Matanzas.
56. Williams & Balfour & Company.
Chile—Antofagasta, Valparaiso.

Measuring Liquids in Ships' Tanks

THE necessity of having a constant check on the depth of liquids in ships' tanks so that the vessel may be kept in proper trim at all times is too well known to need comment. Methods for measuring liquids vary, however, and, although there are few successful devices in operation at the present time, the problem is receiving more or less consideration by shipowners and operators.

The latest equipment having the measuring of the depths of liquids in deep tanks as its object and which has proved successful on extensive trials is a combination of a tank gage and draft indicator with an averaging clinometer. These instruments are being produced by the A. A. Merrick Company, Inc., Philadelphia, Pa.

The outstanding features of this instrument are its accuracy, safety, simplicity, independence, reliability, ease of operation and the short time required for installation. To the owner it means a saving of money by enabling his engineer to order only as much high-priced oil as is required, and, by affording an accurate check on receipts, to avoid the usual "adjustment" after fueling. To the engineer it offers a clean and handy means of checking his receipts and consumption of fuel oil.

OPERATION OF TANK GAGE AND DRAFT INDICATOR

The tank gage consists primarily of a glass connected at its upper end to a mercury U-tube having a scale graduated in feet and inches. From this connection at the upper end of the tube a ¼-inch pipe leads to a vacuum producer. This pipe is provided with a cock for opening and closing the line, and a second one for controlling the inflow and exhaust of air. A 1-inch pipe leads from the

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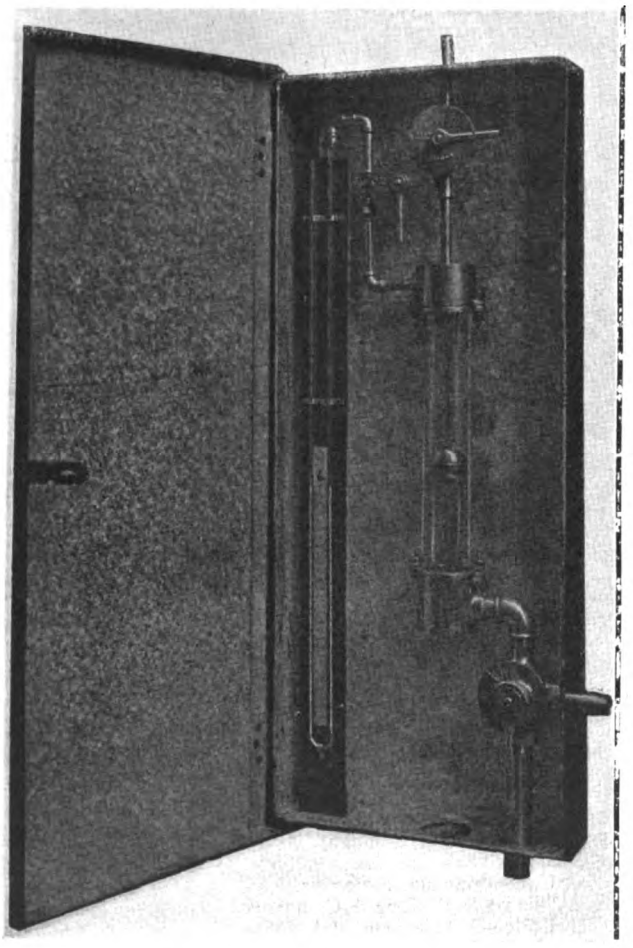
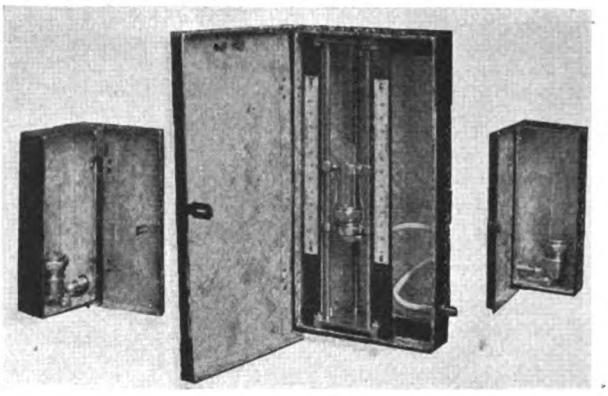
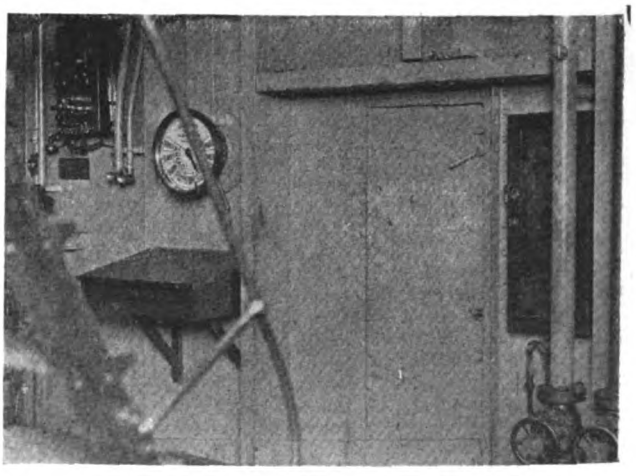


Tank Gage and Draft Indicator



Averaging Clinometer with Trim and List Units



Typical Installation on Engine Room Bulkhead Within Reach of Watch Officer

bottom of the gage glass to the fuel oil manifolds or the cross connection pipes between manifolds, so that by opening the proper manifold valve the gage may be put in communication with any tank.

In explaining the theory of operation the device may be compared to two U-tubes. The first of these, of the commercial type containing mercury, carries a scale arranged in plain sight of the operator. The other tube consists of a gage glass, a 1-inch pipe below it, a cross connection, a manifold, an individual suction line to the tank, and the tank itself. One end of the mercury U-tube is always open to the atmosphere, as is also the tank through its air escape pipe.

The gage is usually secured in a position convenient for inspection. When it is installed, a point is established and marked on the glass, which is a given recorded distance above the bottom of the tank. By opening the proper manifold valve and varying the vacuum or pressure in the gage glass the oil from any tank may be brought to this mark and sustained there. The two U-tubes are thus brought into balance. The vertical height of mercury in the tube is a measure of the height of the oil, these being in the inverse ratio of their specific gravities. From this relation we may find the vertical height of oil sustained above its natural level in the tank. The difference between this value and the distance between the bottom of the tank and the mark on the glass (previously determined) is the depth of oil in the tank. The scale is graduated so that this depth may be read directly, while a separate scale is provided for each degree Baumé of oil.

If the ship is down by the head, for example, the forward double bottom tanks and the oil contained are lower in relation to the gage. The scale reading in this case would be less than the actual depth in the tank by the amount the center of the tank had been lowered. This amount is actually the fore and aft horizontal distance between the gage and the center of the tank multiplied by the sine of the angle of trim. Corrections for all angles of trim and list are computed for each gage.

Determining the Angles of Trim and List

For the purpose of keeping a constant record of the trim and list of a vessel, an averaging clinometer is provided. This device, consisting of three members, is usually fitted in a convenient corner of the engine room. The center or movable member of the device is secured in the corner, the second member 100 inches forward or aft of this, and the third member 20 inches inboard of the first. The fore and aft and transverse units are connected to the center member by ¼-inch pipes and three-way valves. Each of the tubes is partially filled with light oil which stands at a marked point in each of the glasses. If the three-way valve is turned so that the movable member and the fore and aft member are in communication and the ship goes out of trim, the liquid will rise or fall in the movable glass. This glass may be raised or lowered until the liquid attains its original level, and by this procedure the distance moved is a measure of the angle of trim and is read directly from the scale.

Listing is measured in a similar manner by putting the first and third members in communication. Clinometers are ordinarily adjusted to measure the trim accurately to within 0.02 degree and listing to 0.10 degree, but the instrument may be arranged for finer readings if desirable.

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Both the gage and clinometer are accurate when the vessel is rolling or pitching. A ship in motion causes the liquid to move up and down both in the gage and the clinometer glass, but by choking down slowly on the 1-inch cock and the three-way valve the motion is damped until a correct average is obtained.

The one precaution necessary in taking readings on the gage is to be sure that the oil is brought to the mark on the glass and maintained until the scale is read. This is accomplished by manipulating the vacuum and air cocks to secure the desired results.

VACUUM PRODUCER

Both vacuum and pressure are required in the operation of the gage—vacuum if the level of oil is below the mark on the gage glass and pressure when the level is above the mark, which is usually the case in settling tanks. When pressure is required it is produced by the oil itself, which in attempting to seek its own level compresses the air contained in the gage and is prevented from rising further, since this pressure kills the head of oil forming it.

Vacuum is produced by a 30-gallon cylindrical tank located 32 feet above the tank top. A ½-inch pipe runs from the bottom of this tank to the bilge where the end is covered by a water seal. The tank is filled with sea water from the sanitary system. When the tank is full (as shown by the overflow pipe) the filling pipe is closed, the overflow closed, and the drain pipe opened. The water in the water seal is under atmospheric pressure, while that in the tank is under no pressure at all. The vacuum line from the gage enters the top of this tank by a check valve, and this makes available for use in the gage what is practically a perfect vacuum. As the gage is used the vacuum is gradually relieved, and when it has fallen to the point where it will not draw oil into the gage glass it is necessary to refill the tank. All controlling valves are placed alongside the gage box.

A small leak in any of the connections does not affect the accuracy of the gage, as the air drawn in will bubble up into the glass and pass on to the vacuum producer. Should the leak become so great that the oil cannot be drawn into the glass, it must be stopped up, for in such a case the fuel oil transfer pump is not able to get the proper suction. In practice it is found that the individual tank suction lines, the manifolds and the cross connections are always full of oil except when the tank has been pumped dry so that it is not necessary to draw oil all the way from the tank to the gage.

The Economy of Water Transportation

BY SECOR CUNNINGHAM, JR.*

The organization of freight traffic throughout the country is becoming of increasing importance, particularly with the present shortage of rail transportation. Wherever possible, the inland waterways should be utilized to relieve the stress, especially when the operating costs of a river fleet are as favorable as in the carriage of bulk cargo such as the one described in the following article.

THEORETICAL figures seldom have been of much real value in arriving at accurate costs of operation. However, there are times when theoretical figures are the only ones obtainable and consequently we must use them if we wish to even approximate probable costs of doing business.

Suppose, for instance, that a large coal company transports three million tons of coal per year at a present cost of hauling from the St. Louis District to Chicago by rail of $1.50 per ton and that they would make it worth while for a transportation company to determine the probable cost of hauling this coal to Chicago by water.

Some of the figures in such an estimate must be theoretical, because at the present time no one is transporting three million tons of coal per year up the Illinois River and connecting canals, and therefore records of actual operating expenses are not available. Figures of reasonable accuracy may be arrived at, however, and then substantiated by figures of others who are operating under similar conditions. Anyone who is interested in water transportation is generally glad to learn of new projects in this line and will willingly give all possible assistance in determining probable costs.

The secretary of war under the date of March 4, 1920, issued a permit to the governor of Illinois authorizing him to proceed with the improvement of the Desplaines and Illinois rivers between Lockport and Utica, a distance of some 63 miles. Those who are most closely associated with this project believe that if this work is pushed the new waterway will be completed within about three years.

Although it may seem rather unusual to prepare figures, the practicability of which cannot be tested for three years, it must be realized that it will no doubt take considerable time for the investigating company in question to arrive at a decision on the matter. Furthermore, after such a decision is made the condition of the market will undoubtedly cause many unforeseen delays in the delivery of the necessary equipment. Therefore we can safely go ahead with the proposition and endeavor to collect all available figures.

PERIOD OF NAVIGATION ON RIVERS

One of the items which affects this proposition to a great extent is the question of the number of days each year that the waterway will be navigable. An investigation, however, has shown that this item will vary from 240 to 270 days per year. It is felt that in view of this it is safe to assume that under normal conditions river operation can be carried on for an average period of 250 days each year. Based on this figure it will be necessary to bring into Chicago 12,000 tons of coal each of the 250 days in order to meet the required total of 3,000,000 tons per year.

EQUIPMENT NECESSARY FOR PROJECT

In making a decision as to the type of equipment, there is little doubt as to the advisability of using towboats and barges in preference to a fleet composed of barges, a certain number of which are driven by their own power. While the latter fleet is sometimes advantageous for han-

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dling package freight, it is generally agreed that the former will prove more efficient for the hauling of coal. One of the chief reasons for this, of course, is the fact that in order to operate the fleet most economically, all units, and especially the power units, must be kept working for the greatest possible amount of time. In other words, it is less expensive to hold a plain barge at a dock for unloading than it is to hold a power barge which costs probably ten times as much money. The high rates of interest which it is necessary to pay make it highly desirable to get the greatest possible amount of work out of the investment during its operative life. This, of course, is true in any work, but is more especially true in reference to water transportation equipment which is so costly.

Towboats and Barges

The sizes of towboats and barges are directly dependent upon the dimensions of the locks and the stream itself. At present it is contemplated that the locks will be 600 feet long, 110 feet wide and have a minimum depth of 8 feet, and that at no point shall the stream itself be less than 160 feet wide or less than 8 feet deep.

With these dimensions as a guide, it has been decided that a barge with a carrying capacity of 750 tons will prove most efficient for operation on this waterway. The length of this barge would be approximately 160 feet, the width 34 feet and the depth 8 feet.

In order to determine the number of towboats and barges that will be needed, we must first estimate the running time for the round trip. As closely as can be determined at the present time, the average rate of current of the river will be two miles per hour. Assuming that boats are used which, when fully loaded, will travel six miles per hour in slack water, we are safe in saying that the average speed upstream will be at least three miles an hour. As to the speed downstream, it is fair to say that an average speed of six miles an hour can very easily be maintained. For the round trip between St. Louis and Chicago, we will then have an average of 4½ miles per hour. At this rate the time for the round trip of 730 miles would be 162 hours, or approximately seven days.

A towboat of 1,000 horsepower capacity can very readily tow nine 750-ton barges, or a total of 6,750 tons per trip. In order to carry 3,000,000 tons in a year, it would be necessary to make 444 trips. Therefore, as each boat could make but one round trip per week, or 36 trips per season, it will be necessary to have at least 13 towboats.

As to the number of barges, we can figure that we need nine barges for each towboat, nine at the docks in St. Louis and a similar number at the docks in Chicago. To this total of 135 should be added about fifteen barges as a safety factor against accidents and unforeseen delays.

Amount of Investment

A number of large manufacturers of boats and barges have been canvassed and it has been found that the price of a 1,000-horsepower towboat will not exceed $200,000, while a suitable type of barge can be purchased for $20,000. Thirteen towboats at the above price would cost $2,600,000, while 150 barges will amount to $3,000,000. To this must be added $200,000 to cover tugs, launches and other miscellaneous equipment which it will be necessary to have. We then have a total investment of $5,800,000.

Operating Expense

The three most important items of operating expense are wages, subsistence and fuel. As to the former, it is safe to say that with a crew of 16 men to a boat the monthly payroll per boat will be $2,400, or a yearly total for the entire fleet of thirteen towboats of approximately $375,000.

Subsistence will average $1.50 per man per day, and for 13 crews of 16 men each will amount to $115,000 per year.

As the company in question is in the coal business, the cost of coal can be figured at $2.25 per ton. Under average running conditions with a modern type of boat the coal consumption will not exceed 2 pounds per horsepower hour. We shall assume the running time at 90 percent and can then figure the annual fuel costs for 13 boats as follows:

$$24 \times 250 \times \frac{0.90 \times 1{,}000}{2{,}000} \times 2 \times 2.25 \times 13 = \$160{,}000.$$

In addition to the above items are the toll charges and other miscellaneous expense. Toll charges will amount to 5 cents per ton, or on 3,000,000 tons a total of $150,000 per year. Other miscellaneous expense such as oil, waste and general supplies will vary, but can be safely figured at $15 per boat per day. For thirteen boats we can figure the annual expense as follows:

$$250 \times 15 \times 13 \times 0.90 = \$48{,}000.$$

Summing up, the total operating expense will be $848,000 per year.

Overhead

The overhead expense will include the salaries of those in charge of the fleet, their assistants and also the necessary office and clerical force. It is estimated that an allowance of $50,000 per year will be ample to cover this.

Fixed Charges

The amount which should be allotted to fixed charges is, of course, subject to much discussion. Such items as the life of a boat and the upkeep expense during its life are very difficult to determine, but it is felt that an annual charge of 15 percent of the total investment is not excessive. This and the other fixed charges on the $5,800,000 investment are given below:

Depreciation and maintenance at 15 percent.....	$870,000
Interest at 7 percent	406,000
Insurance at 5 percent	290,000
	$1,566,000

Total Expense

With an annual operating expense of $848,000, overhead of $50,000 and fixed charges of $1,566,000, the total expense chargeable to hauling 3,000,000 tons is $2,464,000 per year. The cost per ton therefore would be $.8213, or in round figures 82 cents per ton.

In order to make our figures comparable with the railroad rate between the mines and Chicago, we must add the cost of delivering the coal from the mines to the barges. The cost of hauling the coal from the mines to the river will not exceed 25 cents per ton, including taxes. The expense necessary to transfer the coal from the railroad cars to the barges, including fixed charges on tipples, will be approximately 10 cents per ton. We therefore have a total additional expense of 35 cents per ton.

Adding this to the cost of hauling the coal up the river, the total cost per ton from the mines to Chicago will be $1.17. With an all-rail rate of $1.50 per ton, it is seen that a saving of 33 cents per ton can be effected by using water transportation.

Why, then, if this form of transportation is so cheap, are we not using it to a greater extent? One immediate reason, of course, is that the present waterway from St. Louis to Chicago is not in such condition as to render coal transportation on a large scale profitable. The reason

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that is is not in proper condition at the present time is that those in whose possession has rested the power to improve this waterway have not, until recently, realized the absolute value and positive necessity of spending the requisite amount of money to improve existing conditions. Now that the work has been authorized, however, the next step for those who are interested in this project is to do all in their power to assist those in charge of the improvement to bring the work to completion at the earliest possible date.

One of the best ways to do this is to bring this matter to the attention of big shippers; show them how cheap is this form of transportation and show them how it can readily be adapted to their needs. This, more than anything else, will hasten the day of water transportation, for public sentiment and interest are the greatest possible stimuli to action.

Portable Stacking Elevator

Heavy Bales and Boxes Stacked at Low Cost by Electrical Device Developed at Seattle

GUNNY bales, weighing from 1,400 to 2,000 pounds, are received in large shipments on the piers of the Port of Seattle. So long as these did not need to be piled, no freight handling problem was involved because one man with a two-wheeled truck could deliver the bales at the desired places unaided and at a very low cost. As floor space became more valuable, however, it was necessary to pile the bales two high. The labor cost then increased enormously because it took ten men to lift the bales to the second tier.

A study of the problem undertaken by G. F. Nicholson, chief engineer, and G. Whitestone, electrical and mechanical engineer, of the Port of Seattle, resulted in the development of a portable stacking elevator, which has greatly reduced the cost of unloading cargo of this character. The device resembles a miniature motor-driven pile driver with a steel platform operated in the leads in place of a hammer, the entire apparatus being mounted on an electric truck. The truck is of a standard type operated by storage battery. When it is desired to use the truck separately the clamps which hold the steel frame to the truck body are removed and the pair of pivoted struts at the rear are swung down to bear on the floor. The truck can then be run out from under the elevator mechanism proper.

Construction of the Machine

The mechanism consists of an electric motor geared to a pair of drums on which are wound the hoisting cables that operate the platform. The gear ratio can be suited to the speed required. For handling gunny bales and general freight, a lifting speed of 60 feet per minute has been found suitable. The lifting capacity is about 3,000 pounds. The motor is served by an extension cord from the nearest outlet in the power circuit, but, if desired, a motor could be used which would be operated by the storage battery. The controller for the hoisting motor is provided with an automatic cut-off effected by a cable carrying adjustable stops. This arrangement shuts off the power and sets the brake at a predetermined point. The leads are hinged so they can be laid back to permit the machine to go through doorways. For use in narrow aisleways a turntable has been designed to be placed between the truck and elevator proper. This allows the elevator to be swung around at right angles to the truck, in which position it can handle freight equally well.

Portable Stacking Elevator Developed by Engineers at the Port of Seattle

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METHOD OF OPERATION

For handling gunny bales the machine is placed in the center of the shed floor and truckers with their two-wheeled trucks deliver the bales to the machine platform. In this way the machine can work as many as six piles at a time. The steel platform comes to rest on the floor, and onto this the man with the two-wheeled truck dumps his load without help. The platform then elevates the bale, the machine is moved to the desired location and the platform thrust over the lower tier of bales. While the bale is held in position over the pile the machine backs off. To aid further in finally placing the bale, the platform is slightly elevated and pushed against the bale while the men guide it into place. This operation is very rapid and is said to eliminate at least six men from each crew engaged in putting gunny bales on the second tier. The machine also makes it possible to extend the piles several tiers, if desired, at practically the same cost as for the second tier. Piling gunny bales in three tiers by man power would be impracticable because of the excessive labor cost, but with the machine higher tiering is possible.

An ordinary storage battery truck in this service is found to operate approximately 12 hours without recharging. When a direct current motor is used on the elevator and draws energy from the truck battery, the length of service for each recharge is reduced by about 25 percent. However, the use of a motor connected to the storage battery is recommended by the Port of Seattle authorities because it eliminates the extension cords and the need for power wiring.

SAVINGS EFFECTED

When the first stacker was put in operation on a gunny bale cargo a record of cost data showed a saving of about one-half over the usual cost of handling the bales. The cost of unloading this cargo was $5,000. If five stackers had been available, one for each of the vessel's five hatches, port authorities stated that the cost would have been reduced to $2,500. Enough machines are to be added to the two now in service to permit of an entire cargo being handled by this means.

The machine has been effectively used for stacking canned salmon with the aid of four wheel trailers on which the salmon cases are loaded. A light wooden bottom is placed first and the stack piled on this. These trailers are loaded at the side of the ship and drawn by electric trucks to the stacker. The steel platform of the elevator is run underneath the wooden bottom and the load lifted to the desired height, where the cases are removed by hand. This method releases the trailer as soon as it reaches the stacker and is relieved of its load.

Shipbuilding in American Shipyards

Steel Vessels Under Construction for Private Account—Total Construction of Merchant Tonnage

IN the shipbuilding industry the transition from a war-time to a peace basis was delayed months after a similar change took place in the other major industries in the country whose energies were devoted almost wholly to military uses during the war. As a matter of fact, the shipbuilding programme undertaken by the Government to meet war needs will not be completed until the end of the present year.

SHIPS FOR PRIVATE ACCOUNT

On account of the fact that at the time the Armistice was signed practically the entire shipbuilding capacity of the country was taken up with both merchant and naval work for the Government, it was some months later before facilities became available for the production of steel tonnage for private account. It was not until November, 1919, a year after the Armistice was signed, that any appreciable amount of tonnage was delivered from American shipyards to private owners.

From that time on the delivery of steel vessels to private owners has steadily increased, and as building ways in the shipyards have become available through the completion of Government contracts, an increasing number of contracts from private shipowners have been placed with the shipbuilders so that at the present time the volume of construction for private ownership exceeds that for the Government. According to figures compiled from the records of the American Bureau of Shipping, Lloyd's Register of Shipping and the Shipping Board there were under construction for private account on September 1, 1920, 383 steel merchant vessels of 1,438,498 gross tons as against 166 vessels of approximately 1,049,750 gross tons for the Shipping Board, making a total merchant shipbuilding programme on that date of 549 vessels, aggregating 2,488,248 gross tons.

OIL BURNING VESSELS PREDOMINATE

As far as the steel ships building for private account are concerned 75 per cent of the total tonnage is under construction on the Atlantic and Gulf coasts, 21 percent on the Pacific coast and 4 percent on the Great Lakes. The ships building for private account are divided roughly into two classes—cargo vessels and oil tankers, 43 percent of the total being cargo vessels and 57 percent tankers. All of the tankers are oil burning vessels and 78 percent of the cargo steamships are oil burners, so that oil burning vessels comprise 91½ percent of the total steam tonnage under construction for private account.

Before the war there were in the United States only 38 shipyards with 160 ways equipped for building steel vessels. During the war the number of ways in the original 38 yards was increased to 281 or an increase of 78 percent. At present, the number of shipyards in the country equipped for building steel vessels totals 66 and these yards have a total of 455 ways.

SHIPBUILDING OUTLOOK PROMISING

Owing to the completion of Government contracts, 33 percent of the building ways are now idle, but, in most cases, the idle ways will be found in the new shipyards which were established during the war, the future of which was problematical. On the other hand, there are approximately 175 vessels on order in the older shipyards, keels of which have not yet been laid, due to the fact that ways are not yet available in the yards for laying down new work. Thus it will be found that while many of the

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TABLE I.—STEEL MERCHANT VESSELS BUILDING IN THE UNITED STATES, SEPTEMBER 1, 1920.

	NUMBER	GROSS TONS
For private account	383	1,438,498
For Shipping Board	166	1,049,750*
Total	549	2,488,248

* 1,574,625 deadweight tons.

TABLE II.—STEEL VESSELS BUILDING IN THE UNITED STATES FOR PRIVATE ACCOUNT ON SEPTEMBER 1, 1920.

CARGO VESSELS	NUMBER	GROSS TONS
Coal Burning	20	38,171
Oil Burning	105	425,455
Coal and Oil Burning	13	74,567
Non-propelled	109	82,350
Total	247	620,543
Tankers		
Oil Burning	117	805,964
Non-propelled	19	11,991
Total	136	817,955
Grand Total	383	1,438,498

TABLE III.—STEEL VESSELS STILL TO BE COMPLETED FOR THE UNITED STATES SHIPPING BOARD, SEPTEMBER 1, 1920.

DEADWEIGHT TONNAGE	NUMBER OF VESSELS	TOTAL DEADWEIGHT TONNAGE
13,000	26	338,000
12,500	1	12,500
12,000	7	84,000
11,800	2	23,600
11,375	1	11,375
11,000	5	55,000
10,300	2	20,600
10,200	4	40,800
10,100	5	50,500
10,000	8	80,000
9,600	11	105,600
9,500	4	38,000
9,400	18	169,200
9,000	20	180,000
8,800	8	70,400
8,800	2	17,600
8,000	11	88,000
7,500	14	105,000
7,400	2	14,800
6,000	2	12,000
5,500	1	5,500
5,350	4	21,400
5,000	3	15,000
4,050	3	12,150
1,800	2	3,600
	166	1,574,625*

* 1,049,750 gross tons.

newer yards, after completing their war contracts, are closing up, the major portion of the steel shipbuilding industry, comprising the old well-established yards on the seacoast, whose capacity has been vastly increased since the war began, is running at capacity with sufficient work on hand to keep the yards busy for months to come.

Coupled with the merchant tonnage already in hand, amounting to nearly two and a quarter million gross tons, the shipbuilders are also busy with a large volume of naval construction, much of which cannot be completed inside of two years and which will bring the total volume of vessels under construction well over three million tons. Added to this there is in prospect the construction of a large fleet of passenger vessels—a class of construction that was almost wholly neglected during the war and the need for which is very urgent. Several of the largest steamship companies have already had plans prepared for various types of combined cargo and passenger ships, contracts for which will undoubtedly be placed in the near future. Among these companies are the International Mercantile Marine, the Matson Navigation Company, the Red D and the Munson lines.

As the majority of recent contracts placed by private owners has been for oil tankers it is apparent that the demand for this class of tonnage has by no means ended. As a matter of fact it is reliably reported from authorities in the oil industry on the Pacific coast that a fleet of tankers twice the size of the present fleet now operating on the Pacific will be needed during the next two years to meet the requirements for handling oil.

In other branches of the shipbuilding industry such as yacht and small boat building and more especially in ship repairing, the volume of business in hand and in prospect is very encouraging.

TABLE IV.—STEEL VESSELS UNDER CONSTRUCTION IN AMERICAN SHIPYARDS FOR PRIVATE ACCOUNT SEPTEMBER 15, 1920

BUILDERS	OWNERS	TYPE	GROSS TONNAGE	NO.	TOTAL TONNAGE
American Bridge Company	Portland Cement Company	Barge	300	3	900
American Bridge Company	Bell Iron Works	Barge	600	40	24,000
American Bridge Company	Standard Oil Company	Barge	500	4	2,000
American Bridge Company	U. S. Railroad Administration	Barge	900	25	22,500
American Bridge Company	U. S. War Department	Barge	350	6	2,100
American Shipbuilding Company		Freighter	2,338	4	9,352
American Shipbuilding Company		Freighter	7,700	3	23,100
Baltimore Dry Dock and Shipbuilding Company	Builders	Tanker	6,000	2	12,000
Baltimore Dry Dock and Shipbuilding Company	Builders	Freighter	4,311	2	8,622
Bath Iron Works	Crowell & Thurlow	Freighter	6,250	1	6,250
Bath Iron Works	Crowell & Thurlow	Freighter	6,253	1	6,253
Bayles Shipbuilding Company	Nyack Shipbuilding Company	Tanker	950	1	950
Bethlehem Shipbuilding Company:					
Fore River	Atlantic Gulf & West Indies Company	Tanker	7,800	1	7,800
Fore River	Sinclair Navigation Company	Tanker	6,600	2	13,200
Fore River	Standard Transportation Company	Tanker	7,800	2	15,600
Fore River	Standard Transportation Company	Tanker	7,794	2	15,588
Harlan Plant	Sinclair Navigation Company	Tanker	7,077	2	14,154
Harlan Plant	Sinclair Navigation Company	Tanker	4,500	2	9,000
Moore Poant	International Products Company	Refrig. Str.	3,500	2	7,000
Moore Plant	Western Maryland Railroad	Car Floats	1,200	2	2,400
Moore Plant	Standard Oil Company of N. Y.	Oil Barge	1,200	3	3,600
Sparrows Point	Ore Steamship Company	Tanker	13,500	1	13,500
Sparrows Point	Lux Navigation Company	Tanker	5,845	2	11,690
Sparrows Point	International Petroleum Company	Tanker	13,500	1	13,500
Sparrows Point	Atlantic Gulf & West Indies Company	Tanker	7,800	2	15,600
Sparrows Point	Standard Transportation Company	Tanker	6,900	1	6,900
Sparrows Point	Standard Transportation Company	Tanker	7,500	1	7,500
San Francisco	General Petroleum Corporation	Tanker	7,060	1	7,060
San Francisco	Pan American Petroleum & Transportation Company	Tanker	7,060	2	14,120
San Francisco	Standard Oil Company of California	Tanker	7,060	1	7,060
San Francisco	Standard Oil Company of California	Tanker	8,650	1	8,650
San Francisco	Standard Transportation Company	Tanker	7,060	1	7,060
Brunswick Marine Corporation	R. L. Smith	Freighter	1,250	1	1,250
Clinton Shipbuilding and Repair Company	A. C. Churchman	Tug	75	1	75
Clinton Shipbuilding and Repair Company	Union Petroleum Company	Barge	1,300	1	1,300
Consolidated Shipbuilding Company	United States Bureau of Lighthouses	Lightship	310	1	310
Consolidated Shipbuilding Company	United States Bureau of Lighthouses	Lightship	825	1	825
Consolidated Shipbuilding Company	United States Bureau of Lighthouses	Tender	875	2	1,750
Wm. Cramp & Sons Ship and Engine Building Co.	Florida East Coast Railway	Freighter	2,406	1	2,406
Wm. Cramp & Sons Ship and Engine Building Co.	Peninsula and Ocean Steamship Company	Pass. & Cr.	2,000	1	2,000

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TABLE IV.—STEEL VESSELS UNDER CONSTRUCTION IN AMERICAN SHIPYARDS FOR PRIVATE ACCOUNT SEPTEMBER 15, 1920.

BUILDERS	OWNERS	TYPE	GROSS TONNAGE	No.	TOTAL TONNAGE
Oscar Daniels Company	Standard Oil Company of N. J.	Tanker	7,800	2	15,600
Downey Shipbuilding Company	Southern Pacific Company	Freighter	3,850	3	11,550
Downey Shipbuilding Company	Mexican Petroleum Company	Oil Car.	550	1	550
Dravo Contracting and Construction Company	United States Railroad Administration	Barge	273	4	1,092
Dravo Contracting and Construction Company	United States Railroad Administration	Barge	1,500	15	22,500
Dravo Contracting and Construction Company	Keystone Sand and Supply Company	Barge	500	9	4,500
Duthie, J. F.	Coastwise Steamship Company	Freighter	1,500	2	3,000
John Eichleay Company	United States Engineers	Towboat	200	1	200
Federal Shipbuilding Company:					
Kearny, N. J.	War Department	Barge	350 (see American Bridge Co.)		
Kearny, N. J.	Freeport Sulphur Company	Freighter	4,127	1	4,127
Kearny, N. J.	Sinclair Navigation Company	Barge	500	3	1,500
Kearny, N. J.	Standard Oil Company	Tanker	10,000	5	50,000
Kearny, N. J.	Mexican Petroleum Company	Barge	450	4	1,800
Kearny, N. J.	United States Steel Corporation	Freighter	6,000	6	36,000
Chickasaw, Ala.	Builders	Freighter	6,869	1	6,869
Chickasaw, Ala.	United States Steel Corporation	Freighter	6,000	10	60,000
Geo. A. Fuller Company	Builders	Freighter	6,121	4	24,484
Globe Shipbuilding Company	Builders	Freighter	5,700	2	11,400
Great Lakes Engineering Works	Horace E. Dodge	St. Yacht	600	1	600
Greenport Shipbuilding Company	Bay State Fishing Company	Trawler	292	2	584
International Shipbuilding Company	Marine and Commerce Company	Freighter	4,200	4	16,800
Johnson Iron Works	Cortex Oil Corporation	Der. Barge	200	1	200
Johnson Iron Works	Builders	Barge	200	3	600
Kyle & Purdy	East Coast Fisheries	Trawler	670	2	1,340
Kyle & Purdy	Max Fleischman	Yacht	250	1	250
Lawley & Son, Geo.	Edgar Farnum	Aux. Yacht	350	1	350
Lawley & Son, Geo.	Mr. Crane	St. Yacht	150	1	150
Long Beach Shipbuilding Company	California Mexican Company	Freighter	200	1	200
Manitowoc Shipbuilding Company	Atlantic Fruit Company	Fruit Str.	1,600	1	1,600
Manitowoc Shipbuilding Company	Builders	Freighter	2,712	3	8,136
McDougall-Duluth Company	Sugar Products Company	Freighter	2,338	3	7,014
Merchant Shipbuilding Corporation	Union Oil Company (Del.)	Tanker	6,250	2	12,500
Merchant Shipbuilding Corporation	American Hawaiian Steamship Company	Freighter.	7,800	2	15,600
Merchant Shipbuilding Corporation	Shawmut Steamship Company	Freighter	7,300	2	14,600
Merchant Shipbuilding Corporation	Cochran Harper Company	Tanker	6,250	2	12,500
Merchant Shipbuilding Corporation	Tidewater Oil Company	.....	.....	2	...
Moore Shipbuilding Company	Matson Navigation Company	Freighter	9,500	2	19,000
Moore Shipbuilding Company	Standard Oil Company of California	Tanker	3,250	1	3,250
Moore Shipbuilding Company	Standard Oil Company of New Jersey	Tanker	7,000	3	21,000
Moore Shipbuilding Company	Vacuum Oil Company	Tanker	7,000	1	7,000
Moore Shipbuilding Company	Southern Pacific Company	Tanker	9,600	1	9,600
Moore Shipbuilding Company	Vacuum Oil Company	Tanker	7,089	1	7,089
National Shipbuilding Company	French Owners	Collier	1,371	6	8,226
National Shipbuilding Company	Cuyamel Fruit Company	Fruit St.	300	4	1,200
National Shipbuilding Company	Pan American Petroleum Company	Tanker	1,371	1	1,371
Newburgh Shipyards, Inc.	Cuyamel Fruit Company	Freighter	3,000	2	6,000
Newburgh Shipyards, Inc.	Union Sulphur Company	Freighter	4,700	2	9,400
New Jersey Dry Dock Company	East Coast Fisheries	Trawler	355	2	710
Newport News Shipbuilding & Dry Dock Company	Atlantic, Gulf & West Indies Company	Tanker	10,600	2	21,200
Newport News Shipbuilding & Dry Dock Company	Standard Oil Company of New Jersey	Tanker	13,500	2	27,000
New York Shipbuilding Corporation	W. R. Grace & Company	Tanker	9,340	1	9,340
New York Shipbuilding Corporation	United Fruit Company	Tanker	6,800	2	13,600
New York Shipbuilding Corporation	Standard Transportation Company	Tanker	7,794	4	31,176
New York Shipbuilding Corporation	Munson Steamship Company	Freighter	6,000	1	6,000
New York Shipbuilding Corporation	Builders	Tanker	6,800	2	13,600
Northwest Bridge & Iron Company	Swiftsure Oil Transportation Company	Tanker	9,000	7	63,000
Pacific Coast Shipbuilding Company	Associated Oil Company	Motor Tk.	188	1	188
Pacific Coast Shipbuilding Company	Associated Oil Company	Tanker	1,000	1	1,000
Pensacola Shipbuilding Company	Morris Adler	Tug	300	1	300
Pusey & Jones Company	Philadelphia & Reading R. R.	Pas. Ferry	773	2	1,546
Pusey & Jones Company	Eastern Steamship Company	Freighter	2,700	1	2,700
Rice Bros.	Atlantic Coast Fisheries	Trawler	400	4	1,600
Southwest Shipbuilding Company	Luckenbach Steamship Lines	Freighter	6,100	1	6,100
Southwest Shipbuilding Company	Union Oil Company of California	Tanker	8,650	2	17,300
Southwest Shipbuilding Company	Anglo Saxon Petroleum Company	Tanker	5,600	3	16,800
Southwest Shipbuilding Company	Union Oil Company of California	Tanker	4,788	1	4,788
Spedden Shipbuilding Company	Standard Oil Company of N. J.	Barge	995	1	995
Spedden Shipbuilding Company	Builders	Tug	325	1	325
Standard Shipbuilding Corporation	Cuyamel Fruit Company	Fruit Str.	900	2	1,800
Standard Shipbuilding Corporation	Eagle Oil Transportation Company	Tanker	5,600	4	22,400
G. M. Standiter Construction Company	Standard Oil Company of New Jersey	Tanker	8,250	3	24,750
G. M. Standiter Construction Company	Imperial Oil, Ltd.	Tanker	8,250	2	16,500
Staten Island Shipbuilding Company	Galena Signal Oil Company	Tanker	2,500	1	2,500
Staten Island Shipbuilding Company	American Sugar Refining Company	Tanker	4,200	1	4,200
Staten Island Shipbuilding Company	Standard Oil Company of New York	Barge	420	6	2,520
Staten Island Shipbuilding Company	Standard Oil Company of New York	Mot. Barge	450	1	450
Staten Island Shipbuilding Company	Tidewater Oil Company	Tanker	1,200	1	1,200
Submarine Boat Corporation	Builders	Freighter	3,545	16	56,720
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker	9,000	4	36,000
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker	6,700	1	6,700
Sun Shipbuilding Company	Pan American Petroleum & Transportation Company	Tanker	6,700	2	13,400
Sun Shipbuilding Company	Sinclair Navigation Company	Tanker	6,700	2	13,400
Sun Shipbuilding Company	Standard Oil Company of New Jersey	Tanker	6,800	2	13,600
Sun Shipbuilding Company	Union Oil Company	Tanker	9,000	2	18,000
Sun Shipbuilding Company	Societe Anonyme d'Oriente d' Industre	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Tidewater Oil Company	Tanker	6,800	1	6,800
Sun Shipbuilding Company	Norwegian American Line	Tanker	6,800	1	6,800
Tank Shipbuilding Corporation	Southern Oil and Transportation Company	Barge	835	1	835
Tank Shipbuilding Corporation	Sunset Fuel Oil Company	Oil Barge	1,250	1	1,250
Terry Shipbuilding Corporation	U. S. Mexican Oil Transportation Company	Tanker	5,190	3	15,570
Texas Company	Builders	Tanker	6,700	5	33,500
Texas Company	Builders	Mot. Tan.	3,500	1	3,500
Texas Company	Builders	Barge	750	3	2,250
Todd Shipyards Corporation (Tebo Yacht Basin)	Donald Steamship Company	Freighter	1,400	2	2,800
Todd Dry Dock & Construction Company	Stock	Freighter	4,600	1	4,600
Toledo Shipbuilding Company	Stock	Freighter	2,559	1	2,559
Union Shipbuilding Company	Builders	Freighter	7,150	4	28,600
Union Shipbuilding Company	Gulf Refining Company	Tanker	6,700	2	13,400
Union Construction Company	General Petroleum Company	Tanker	7,000	1	7,000
Union Construction Company	Standard Oil Company of California	Tanker	7,000	1	7,000
Union Construction Company	Standard Oil Company of California	Motor Tk.	1,650	1	1,650
Union Construction Company	Shell Oil Company	Tanker	7,000	1	7,000
Union Construction Company	Anglo Saxon Petroleum Company	Tanker	5,600	3	16,800
Virginia Shipbuilding Corporation	United States Steamship Company	Freighter	6,060	3	18,180
Total				396	1,449,859

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Giving Effect to the Merchant Marine Act

BY WALDON FAWCETT

With only the nucleus of a Shipping Board to shoulder the responsibility, and with impulse to mark time on the formulation of all administrative policies until after the Presidential election in November, effect is nevertheless gradually being given to some of the most important provisions of the new Merchant Marine Act. It is significant that the features of the national maritime programme that have been the first to be formulated are those that have most direct and immediate contact with the practical side of the shipping and shipbuilding industry.

BY reason of possible influence upon private credit policies and terms in the shipbuilding industry, there is interest, aside from its obvious application, in the new ship sales policy formulated by the Shipping Board. The Board construed itself to be charged, under the provisions of the new act, with the duty of adopting and executing a ship sales policy that would, in fact, establish the merchant marine of the United States upon a sound operating and financial basis. To that end the Board undertook a careful survey of conditions in the maritime field with respect to costs of operation, current revenue, competitive conditions, present and prospective, and the bearing upon the waterborne transportation interests of the general financial and economic situation.

Ship Sale Plan

In the light of disclosures and conclusions reached, the Shipping Board evolved its ten-year sales plan for vessel property. Under this system a purchaser of new steel tonnage is under the necessity of paying in cash at the time of the delivery of the vessel only 10 percent of the purchase price. At the expiration of a period of six months after delivery of the vessel there is due a payment of 5 percent. Thereafter at intervals of half a year there are due similar payments of one-twentieth of the purchase price, the discharges of the obligations thus being spread, it will be noted, over a period of ten years. All deferred payments carry interest at the rate of 5 percent.

The arrangements for segregating the income of tonnage purchased from the Government on this plan will doubtless prove of interest to shipping men, even though they have no intention of making purchase in this quarter. All revenues derived from vessel operation, in the case of craft acquired on the installment plan, are to be deposited in a controlled or supervised account. From this account all payments upon the tonnage may be paid as they become due, except, of course, the initial payment which the buyer is required to raise strictly upon his own resource, as though in testimony to his responsibility.

Dividends

By way of net profit or dividend upon the operation of vessel property, the gross income of which is to be held as above indicated, a purchaser is to be permitted to take from the proceeds of operation, after the current installments are paid, a sum not exceeding 15 percent upon paid-up installments, this withdrawal to constitute a dividend upon the investment and to be distributed to the stockholders of the purchasing corporation in any manner that may be agreeable to the shareholders. When 50 percent of the purchase price has been paid, the buyer of tonnage is to execute a preferred mortgage on the property to the Shipping Board and thereafter the operation of the vessel is released from the supervision and control of the Board, except as to maintaining berth and route. The obligation of the vessel owner still holds also, of course, with respect to the scheduled payments of principal and interest at semi-annual intervals.

Awaited with especial curiosity by the shipbuilding industry was the price that the Shipping Board should fix on its tonnage for sale. The subject of the minimum price per ton to be asked was discussed at the greatest length, it may be recalled, in hearings conducted earlier in the year by the Merchant Marine Committees of the Senate and House of Representatives. Shipping men and shipbuilders were quizzed in detail as to the degree of disregard which Uncle Sam should, in reselling, show for the contract price (in excess of $200 a ton) which had been paid on war-time commitments and as to the prices that might be expected to prevail on new tonnage as the industry settled back into its stride after post-war readjustment. In the degree in which the Board's basic price should constitute either a compromise or an anticipation of future price conditions has there been curiosity with respect to the quotations to be named. The figures, as announced, ranging from $160 to $185 per ton, with a uniform differential of $10 per ton for oil burners over coal burners, bear evidence of an attempt on the part of the price fixers to strike a medium between the estimates made by consulting experts.

Prices Asked

A minimum price of $175 per deadweight ton for coal burners and $185 for oil burners has been named for three classes of vessels. These comprise, respectively, the American International Ship Building Corporation type, of 7,800 deadweight tons; the Skinner & Eddy type, of 8,800 deadweight tons, and the Skinner & Eddy type with a range of 9,600 to 10,067 tons. Lumped with the latter, at the price indicated, are all other vessels over 10,000 deadweight tons excepting combination cargo and passenger vessels, oil tankers and refrigerator vessels. Price pegged at $160 per deadweight ton for coal burners and $170 for oil burners are two groups of vessels, viz., those built on the Great Lakes for ocean service and the Submarine Boat Corporation type, as it is popularly designated, with a tonnage of 5,350. The reader will, of course, understand that it is the policy of the Shipping Board to entertain bids on the various types, sizes and classes of vessels, with awards going presumably to the highest bidder who is able to offer full and satisfactory evidence of financial ability to meet obligations as they become due. The prices named are designed to stand as minimums below which no bids would be entertained.

Deduction for Depreciation

The fixed prices must, manifestly, be made subject to deduction for depreciation, and because the question of consistent allowances for depreciation is always an interesting topic in shipping and shipbuilding circles, and doubly so in the face of the current marine insurance situation, the policy of the Shipping Board on this score was awaited expectantly. The conclusion of the Board is that deduction

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for depreciation should be allowed at the rate of 6 percent per annum for the second year of the vessel's age and 5 percent per annum for every year thereafter to date of purchase, depreciation to be allowed for whole months only and up to the estimated dates of delivery.

Of importance to shipping and shipbuilding interests has been the action of the Shipping Board looking to the extension to owners and operators of vessels of the privileges vouchsafed to them by Section 23 of the Merchant Marine Act. This is the section of the law that seeks to encourage the upbuilding of the United States merchant marine by the experiment of affording relief from Federal taxes. The section of the law above cited allows owners and operators of vessels documented under the laws of the United States and engaged in foreign trade in reporting net income to make a deduction, while the vessel is so operated, for each of the ten taxable years, beginning with the first taxable year ending after the passage of the Merchant Marine Act, of an amount equivalent to the net earnings of the vessel during the year.

Section 23 of the Jones Act

What will constitute "net earnings" within the meaning of this section of the law will probably require time to work out. There has been delay in the promulgation of the basic rules and regulations, and with these in force the disposition of a certain number of test cases will doubtless be required to establish the precedents that will serve for guidance. In the meantime, however, shipping interests are moving to take advantage of the exemptions promised. Among the applications already filed and considered in order are those of the Crowell & Thurlow Steamship Company, of Boston; W. R. Grace & Company, of New York, and the Pacific Mail Steamship Company.

It is stipulated in that section of the Merchant Marine Act which gives relief, as indicated, from taxes that the waiver is to be made only in the event that the exempted owner or operator shall deposit in a trust fund a sum equivalent to the war profits and excess profits taxes which he escapes. The trust fund referred to is, in each instance, to be devoted to the construction in shipyards of the United States of new vessels of a type and kind approved by the Shipping Board. In this last we have an important detail of the current activity. The companies above indicated and several others have filed data as to the types of vessels that they intend to construct with the funds that might be accounted a tax rebate.

New Shipbuilding Contracts Encouraged

The New York Shipbuilding Corporation is designated as beneficiary of this new stimulus to shipbuilding in two instances. W. R. Grace & Company has communicated intention to place a contract with the New York Company for a 10,000 deadweight ton oil tanker, and the Pacific Mail Steamship Company will entrust the same yard with a contract for an oil tanker of 9,800 tons deadweight. The Crowell & Thurlow Company obligates itself to put the equivalent of its remitted taxes into two cargo steamers of about 4,400 tons deadweight to be laid down at the Bath Iron Works, Bath, Me. The Sun Company, of Philadelphia, seeks to divert its Federal tax tolls to the construction by the Sun Shipbuilding Company, at Chester, Pa., of a single screw bulk oil steamer of about 12,000 tons deadweight and the Newcastle Shipbuilding Company, of Newcastle, Me., has sought sanction from the Shipping Board of a five-masted schooner now under construction as a type of vessel worthy of the investment of trust funds set aside in accordance with the indulgences of the new law. That there is no discrimination against schooners as fit subjects for the exercise of the authority conferred under Section 23 is attested by the fact that the Shipping Board has indeed already approved under this stipulation, the plans of the five-masted schooner above referred to and which is building to the account of the Boston Maritime Corporation, Boston, Mass., and Richard Diebold, of Newcastle, Me.

The most ambitious undertaking in quest of the benefits promised by Section 23 is that of the Standard Transportation Company, of 26 Broadway, New York, which undertakes to add to its fleet ten oil tank steamers. Four of these steamers, each of 12,620 tons deadweight, will be constructed by the Bethlehem Shipbuilding Company, at Quincy, Mass., and four tankers of like tonnage will be built by the New York Shipbuilding Corporation, at Camden, N. J. In addition, the Bethlehem Company undertakes two tank steamers of 10,000 tons each, one at its Sparrows Point, Md., yard and the other at the Union plant at San Francisco.

American Classification Promoted

That the Shipping Board intends to lose no opportunity to further its policy, as already revealed, with respect to American facilities for classification, was disclosed incident to the approval of the application of the Standard Transportation Company. In approving the plans of the ten vessels thereby authorized the Board decided that they should be constructed to meet the classification requirements of the American Bureau of Shipping. It is understood that this requirement will henceforth be a condition of the extension, in any instance, of approval as required by Section 23. This is but part and parcel of what appears to be a determined policy in behalf of the Americanization of the United States merchant marine. Readears are perhaps familiar with the appeal recently issued to insurance interests in behalf of the development of American resources in marine insurance, and coincident with this is the drive of the Shipping Board, through the operators and managers of Shipping Board vessels, to induce the fullest employment of our own nationals. In this connection it is announced that the statistics of the Sea Placement Bureau of the Shipping Board show that an average of six out of every ten men now entering the service of vessels under Shipping Board control are American citizens. To replace all foreigners by Americans will be, it is declared, a studied policy in so far as it may be carried out without delaying operations or crippling vessels for lack of American crews.

Relations with Foreign Countries

With the Shipping Board proceeding, step by step, to work out the practical policies prescribed by the new Merchant Marine Act, there has been injected more and more conspicuously into the situation an element of "politics" due to the reaction in various maritime nations to what are commonly known as the "preferential clauses" of the Jones Act. A spirit of competition, if not of resentment, has been quickened in various foreign quarters not less by the discriminatory features of this nation's new arrangements than by the circumstance that a programme of team-play has been perfected between the American Ship & Commerce Corporation and the Hamburg-American Line. For American shipping and shipbuilding interests the significance of this compact is that it places at the disposal of American interests all the technical knowledge and experience of what was, before the war, the premier steamship company of the world, yet gives to the United States first call in supplying tonnage for service on all of the Hamburg-American Company's old trade routes and in

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no event permits German participation to extend beyond 50 percent of the tonnage in either freight or passenger service.

Beginning with his correspondence with C. J. France, of Seattle, Wash., Admiral W. S. Benson, chairman of the Shipping Board, has shown no disposition to ignore criticism nor dodge the issue precipitated by Section 28 of the new law, the purpose of which, as Admiral Benson conceives it, "is to build up the American merchant marine by protecting United States ports in the enjoyment of an export traffic moving in American ships and to offset the countless discriminations by other nations against American shipping." While frankly ready to join the issue, the head of the Shipping Board will not allow the official attitude to be represented as unduly drastic.

Shipping Board Prepared to Meet the Issue

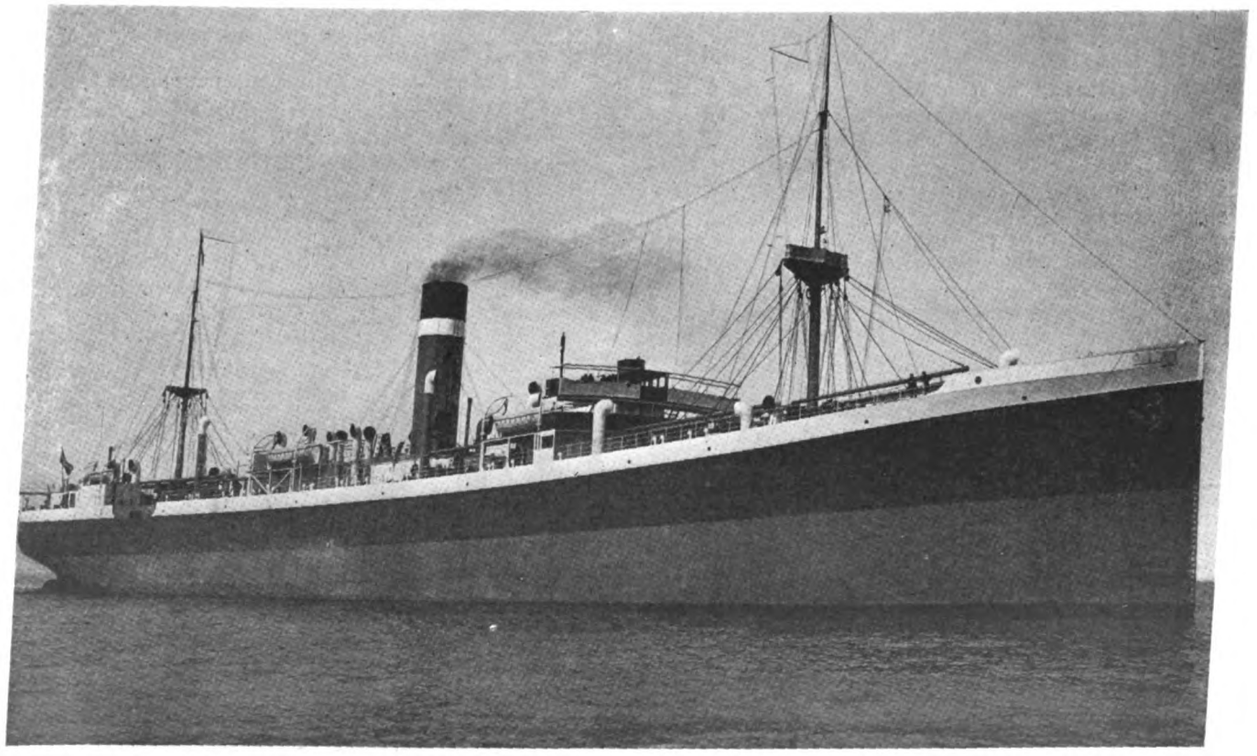
He insists, for example, that it is not the purpose of the Shipping Board, in the legislation it has furthered, to give them such advantages as would offset foreign advantages and permit them to carry at least a considerable portion of the commerce between the United States and foreign countries. In dealing with the situation at Seattle, moreover, Admiral Benson has made it anything but difficult to read between the lines of a statement in which he has said that the Shipping Board, in allocating and operating its vessels, must be assured of the loyal support of the home ports from which they are to operate. Domestic discussion of the effect of Section 28 of the Merchant Marine Act has been intensified, naturally, by the delay beyond the prescribed ninety-day period of notification to foreign governments of the intention of the United States to revoke certain clauses of existing commercial treaties. Some twenty-five treaties are affected and it is intimated that the period allowed by law afforded none too much time for the careful analysis of these instruments on the part of the Department of State.

Fruitful of speculation as indicative of the play of inside administrative "politics" in the Shipping Board have been the changes recently announced in the legal annex of the Board. The outstanding feature of this change is the combination, under one head, of the legal departments of the Shipping Board and the Emergency Fleet Corporation, which have heretofore been kept separate and distinct. The Admiralty Department will, owing to the nature of its work, be kept separate in the future as in the past from the Legal Department. That a sequel of the reorganization of the Legal Department will be found in the abolishment of the Bureau of Investigation is a contingency of definite interest to shipbuilders and ship equipment and supply firms, inasmuch as it has been depended upon to pave the way for the payment of thousands of long-standing claims against the Government. If there is to be a slowing down of the operation of the claims department the outlook is anything but encouraging to firms that desire to close up accounts.

Cargo Steamer City of Brisbane Built for the Ellerman Lines, Ltd.

ANOTHER fine cargo boat has just been added to the fleet of the Ellerman Lines, Ltd., of Liverpool, for their Hall Line service to India. This is the *City of Brisbane*, built to Lloyd's highest class by Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne.

The ship, which has a cruiser-shaped stern, is to carry about twelve thousand tons deadweight on a draft of 27 feet 10 inches. Her chief dimensions are: Length between perpendiculars, 462 feet 9 inches; extreme beam, 58 feet 5 inches; molded depth, 33 feet 5 inches. The main engines, built by the Wallsend Slipway & Engineering Company, Ltd., consist of double reduction geared turbines of the Brown Curtis type, which drive a single propeller. The four boilers working under forced draft also come from the shops of the engine builders.



Steamship *City of Brisbane* Recently Added to the Ellerman Lines, Ltd.

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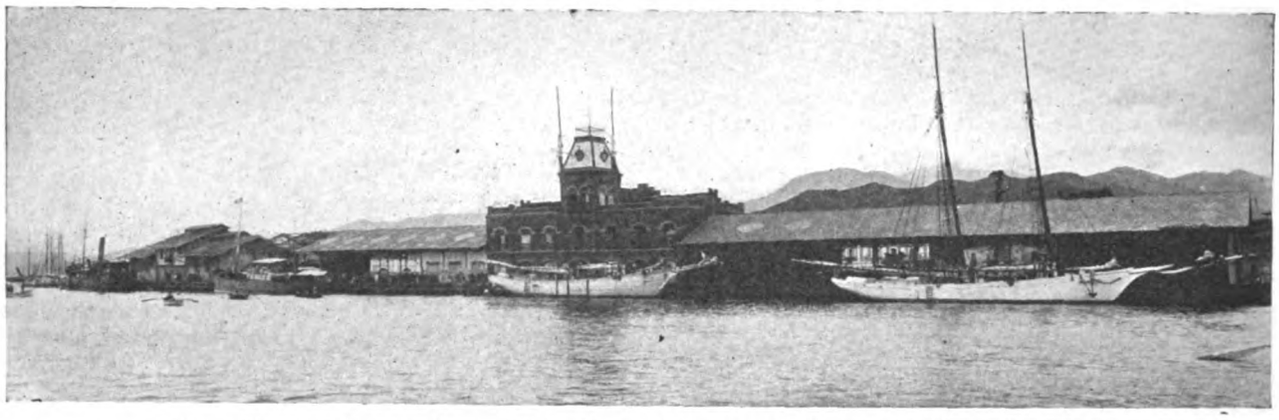

Custom House and Dock at Puerto Cabello, One of the Deepest Harbors on the Western Hemisphere

Shipbuilding and Shipping in Venezuela

BY HARRY CHAPIN PLUMMER

SHIPBUILDING and ship repairing, ship chandlery and the maritime trades along the Venezuelan coast are on the rapid increase and have been since the outbreak of the world war, which forced the northernmost of the South American republics to fall back upon her own not inconsiderable resources for the provision and upkeep of such tonnage, both steam and sail, as she required for her swiftly developing coastal trade and her commerce by sea to the nearby republics of Colombia and Panama and to Cuba and the American, Dutch, English and French West India Island possessions.

Harbors and Navigable Rivers

Not only has Venezuela a magnificent coast line of hundreds of miles on the open Caribbean, and that includes many excellent natural harbors, but the broad Orinoco, with its uninterrupted deep channel flowing through the Delta to the sea constitutes one of the world's finest inland waterways. It is from Ciudad Bolivar, the populous city on the north bank of the famous stream, that much of the country's large export trade with Trinidad is conducted, and so active and constant is the intercourse between Ciudad Bolivar and Port of Spain, the seaport and capital of Trinidad, that English is spoken at the Orinoco port as a second language. When one encounters a native resident of Ciudad Bolivar at Caracas, the capital city of Venezuela, or elsewhere in the interior, it proves to be the rule rather than the exception that he speaks English and, more often than not, speaks it fluently.

Tables I and II will convey an idea of the extent of the newly developed maritime trade of Venezuela, a chief factor in which has been the construction by the Venezuelan government, almost entirely since the beginning of the war, of a superb system of motor highways which now connect such port cities as La Guaira, Puerta Cabello Carupano and Cristobal Colon with Caracas, Valencia, the highland industrial city 115 miles westward of the capital, Barquisimeto, Cumaná, Barcelona and the more distant colonial cities in the Cordilleras of the Andes, such as Merida, Tachira, Trujillo and San Cristobal.

Interior Trade Routes Revolutionized

The new network of roads naturally has revolutionized the interior trade routes of the country, which hitherto were confined to "old Spanish trails," mere paths for oxen, and, in the mountain regions, for pack burros and their drivers walking in single file. The consequent rerouting of such important major products of Venezuelan

TABLE I.—MARITIME TRAFFIC BETWEEN CHIEF PORTS OF VENEZUELA AND COLOMBIA AND PANAMA, CUBA AND AMERICAN, DUTCH, FRENCH AND BRITISH WEST INDIA ISLAND POSSESSIONS, JULY TO DECEMBER, 1918

	Imports		Exports	
	*Kilograms	*Value	*Kilograms	*Value
Islands of Archipelago of Curacao:				
Aruba	8,324	Bs.5,470	215,925	Bs.55,977.10
Bonaire	86,738	13,758	304,479	65,256.50
Curacao	1,139,024,750	262,478	24,351,447,300	7,029,538.61
Barbados			1,829,242	256,940.30
Cuba	86,408	20,032.01	174,712	112,008
Colombia	484,449	618,998.73	634,046	465,455
Panama	254,250	286,001.15	17,580	26,670
Porto Rico	402,429,650	610,883.05		
Trinidad	150,126,850	166,524.52	12,374,140,800	5,503,545.62
Martinique	72,005	84,743	3,357,212,700	687,152.90
Santa Lucia			3,687,252	1,735,377
	2,683,755,250	Bs.2,068,888.46	46,947,036,800	Bs.17,037,907.03

* Kilogram equivalent to 2.2046 pounds. Venezuelan bolivar normally equivalent to 19.3 cents American gold.

TABLE II.—VESSEL CLEARANCES FROM CHIEF PORTS OF VENEZUELA BY SHIP REGISTRIES, JULY TO DECEMBER, 1918

	Vessels		Tonnages		Totals	
	Steamships	Sail	Steamers	Sail	Ships	Tons
American	60	7	81,078	1,659	67	82,737
Spanish	15	....	57,788	.....	15	57,788
French	22	9	11,893	1,910	31	13,803
Dutch	17	106	9,404	5,859	123	15,263
English	44	10	53,090	696	54	53,786
Italian	4	....	22,772	.....	4	22,772
Norwegian	7	....	9,582	.....	7	9,582
Venezuelan	36	836	7,306	21,858	872	29,164
Totals	205	986	252,913	31,982	1,173	284,895

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agrarian and mining activity as sugar, coffee, cocoa, cotton, corn, tobacco and sisal and ores, cement, coal and oil, with which latter the western areas of the republic are prolifically supplied, has necessitated the opening up of new seaboard gateways.

At Ocumare de la Costa the Venezuelan Ministry of Public Works has completed a modern dock, which will be equipped with the most approved type of discharging and loading apparatus, terminal railway facilities and warehouses and, too, will be the seat of an up-to-date *congelacion* with meat chilling, instead of meat freezing, mechanism to take better care of the great volume of live stock shipments on the hoof and by special cattle carrying motor equipment which it is planned to divert to the new port from the interior *llanos* through Maracay.

New Concrete Piers

The newly completed pier at Ocumare is one of the finest examples of concrete construction in the country. Its total length is 492 feet, its width 19 feet 8 inches and the height of the dock flooring above the sea level 7 feet 10 inches. The cost of the work amounted to $29,397.28, and much of the material for the pier was brought from the United States.

This pier affords a concrete illustration of the scale upon which dock construction and improvement is proceeding at the several ports of the country, among which may be mentioned in particular that of Cristobal Colon, a strategic point of vital importance on the Gulf of Paria, considerably to the seaward of the British Island of Trinidad. There, too, a large modern concrete dock is now in course of construction.

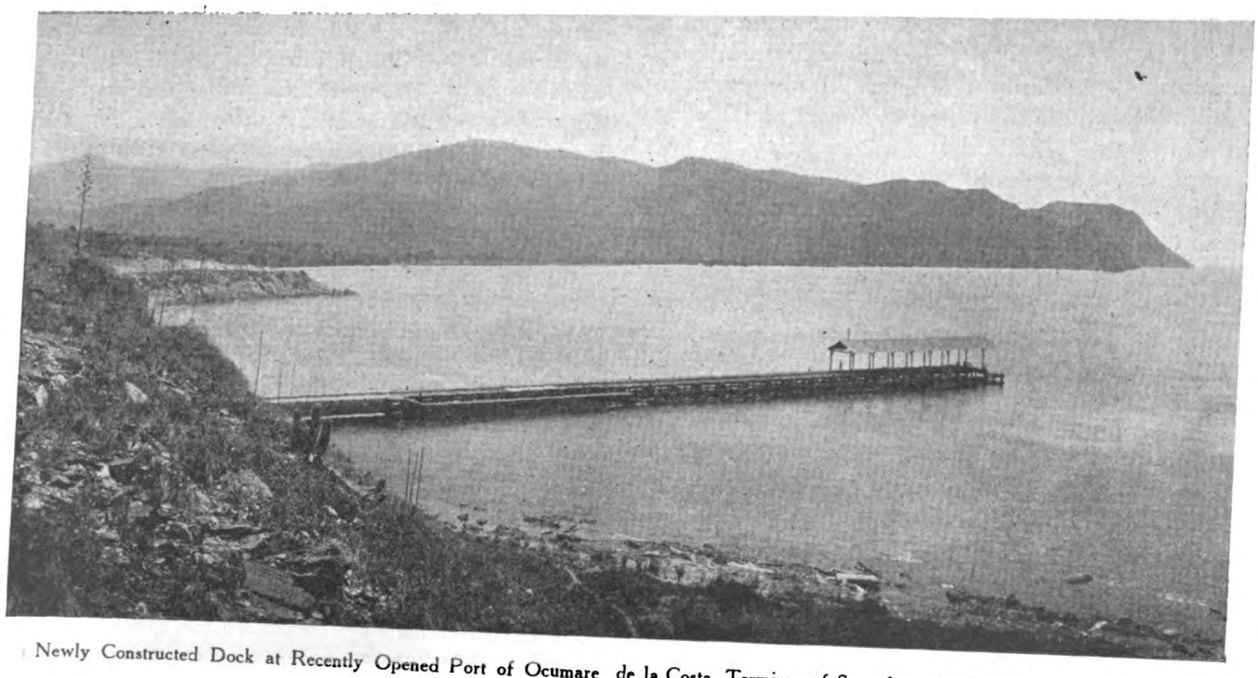
At Puerto Cabello there is situated the *Dique y Astillero Nacional* combined naval and military machine shops and dry docks, where in the last five years not only Venezuelan naval and other government craft but native mercantile and passenger vessels have been constructed and liners regularly plying in trans-Caribbean service between Venezuelan ports and the United States and Europe are accommodated for repairs. A familiar sight in the waters about Puerto Cabello is the Venezuelan gunboat

Dock Construction at the Port of Cristobal Colon, Venezuela. Reinforced Concrete, With Native Cement, is a Leading Factor of Present-Day Building Operations in the Republic

Mareschal Sucre (named for the Venezuelan "Marshal of France," who achieved immortal fame in the Napoleonic wars). This vessel is the erstwhile *Dubuque,* a unit of the American Navy, converted for more restricted cruising patrol in the Caribbean and the Orinoco River and Delta.

"The Dique," as the big Puerto Cabello plant is popularly known, now boasts a good-sized steel dry dock and a smaller one of wood. The former was brought to its permanent location from Erie Basin, Brooklyn, in two sections a year or two ago. It is 282 feet in length, 110 feet outside width, 90 feet inside width and 18 feet maximum draft over the keel blocks, and has a maximum lifting capacity of 3,000 tons. The wooden dry dock is 180 feet long, 80 feet outside width, 60 feet inside width and a maximum draft over keel blocks of 17 feet. It has a maximum lifting capacity of 1,200 tons.

The plant includes a steel foundry of the first class, and is equipped for the construction and repair of ships and of boilers, engines and ships' machinery.



Newly Constructed Dock at Recently Opened Port of Ocumare de la Costa, Terminus of Spur from 1,800-Mile System of Modern Motor Highways

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WE GUARANTEE that of this issue 9,400 copies were printed; that of these 9,400 copies 7,531 were mailed to regular paid subscribers, 442 were provided for counter and news company sales, 408 were mailed to advertisers, 79 were mailed to employees and correspondents, and 920 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 99,050—an average of 9,905 copies a month.

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Annual Index to Be Published Separately

OWING to the shortage of paper, the annual index of MARINE ENGINEERING, which formerly was published as a part of the December issue, will hereafter be published separately at the end of the year. As the annual index will be useful only to those subscribers who have kept a complete file of the magazine for the year, only a sufficient number of copies will be printed to fill the orders received for it at this office on or before December 1. A copy of the index will be mailed without cost to each subscriber whose order is received on or before that date.

Advance in Subscription Rates

WE have to announce to our readers at this time an increase in the subscription price of MARINE ENGINEERING. Hereafter the subscription rate throughout the United States, Canada and Mexico will be $4. The rate to subscribers in other countries will be $5, and the price of a single copy 35 cents.

Publishers, like everyone else in the business world, have been faced with tremendous increases in the cost of materials. For example, the cost of engravings used as illustrations in our editorial pages has gone up 265 percent. Other items have increased as much as 125 percent. In this connection it should be remembered that postage on second class matter was materially increased on July 1, 1920, and that it will be increased *again* on July 1, 1921. We could go into greater detail regarding these matters, but we feel that our readers appreciate the conditions, which are world-wide in scope.

We are planning bigger and better things for MARINE ENGINEERING and we are confident that we will continue to have your support in the future as we have had it in the past. Our aim is to make the magazine of the greatest possible value to its readers and we expect not only to keep all our present readers with us, but to go on steadily adding to our subscribers.

Technical Training in Naval Architecture

NOW that the United States is rebuilding her ancient prestige on the seas, it is interesting to consider what facilities there are for the technical training of experts on whom the qualities of future ships will largely depend. It is not too much to say that during the war the engineer came into his own. Now that the war is ended we find that all the colleges in the land are crowded, and in particular the engineering colleges. Thousands of young men are now laying the foundations for technical careers. If all the ships of the ocean could be assembled, they would make an immense fleet and represent billions of dollars. And yet all the ships, on all the seas, are but a fraction of the industrial contribution of the world, and all the shipyards, with all their workers, are relatively but a handful. And of the workers only a fraction are employed on scientific work.

Two of the leading educational establishments of the country offer fully equipped courses in naval architecture, namely, the Massachusetts Institute of Technology and the University of Michigan; there is also the Webb Academy, which has deservedly a high reputation though not of collegiate grade. For good or ill, the technical schools of the country are standardized; study one and you know all. They all teach pretty much the same thing in the same way; in fact, they cannot well do otherwise, if they are worthy to stand in the first rank. The catalogue of the Massachusetts Institute of Technology is fairly easy to understand because each department has not only all subjects of the curriculum set down, but also the hours both for school work and for home study. Let us see what we can learn about its course in naval architecture.

In the first place, we find that it has the eight-hour day; eight hours a day, six days in the week for the thirty weeks of each of the four school years. A student may have a lecture in theoretical naval architecture and another in ship construction and many have three hours in the drawing room; then he can go home and work three hours by himself. The curriculum for naval architecture is well balanced and well distributed, but there is an interest in seeing what would happen if the work could be bunched. A little simple arithmetic shows that something less than a school year is given to naval architecture and marine engineering, that two years and a half are given to subjects more or less common to all engineering courses, and that half a year is left for non-technical subjects like languages and literature. The last item may well receive careful consideration by those who remember that an engineer is a man with human interests; but we cannot dwell on it now.

Take the middle group of two years and a half. Of this, mathematics gets half a year and physics and chemistry nearly a third of a year each; general engineering gets something less than a year and a half. In general engineering are included drawing, machinery, heat engineer-

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ing applied mechanics and electricity, with plenty of laboratory and shop work. All of our technical schools show a like condition, which is right and necessary, for our engineer must be an all-around man as well as a specialist.

Coming back to the course in naval architecture, we find that its year gives about one-fourth to marine engineering. A ship designer must know something about the engines, be they reciprocating steam engines, turbines or oil engines. That the practical side of naval architecture (ship construction and design) should have twice the attention that is given to theory looks right enough, even if we bear in mind that a man gets his theory in school and practices all the rest of his life. But it may be a little startling to find that all the theory is given in 5½ percent of the four years. If a man could work eight hours a day on dry theory he could clean up the whole thing in seven weeks.

Naval Architects and Marine Engineers

NAVAL architecture and marine engineering are one profession with two branches, just as medicine includes the physicians and surgeons. But every student of medicine receives training in both branches of his profession and every physician can do simple surgery at a pinch, and any surgeon would prescribe if a physician were not at hand.

In the beginning every shipbuilder was a carpenter and every engineer was a mill wright, and they divided their work according to the material. Anyone could then tell where the ship ended and the engine began. Now the case is not so clear. For a reciprocating engine the engine bed is of cast steel and the foundation is riveted up in shapes and plates; but, depending on the designer or designers, the combined structure may be nearly all bed or nearly all foundation.

The engineer naturally has furnished the propeller and usually designs it, though logically the naval architect who powers the ship should be able to control the propeller design. The introduction of intermediate gears between the propellers and the steam turbine, or perhaps between the propeller and the internal combustion engine, enables the naval architect and the engineer to cut loose. The naval architect can design his ship and adopt the best propeller, and the engineer can run his turbine or engine as he will; both may get the best efficiency.

When a ship like a destroyer is built for the highest speed, the design should be centralized in the hands of one man who should be the master of the whole profession of naval architecture and marine engineering. For a slow freighter it may be possible just to build a ship and go out into the market and buy a standard engine.

It is now convenient to have a hull department and an engineering department in a shipyard, and probably always will be. Since business will not tolerate inefficiency, there is always some one, be he president, general manager or what not, who sees to it that the departments gear up correctly.

In both American and British technical colleges the theory of shipbuilding is taught in a course of naval architecture and marine engineering (or including marine engineering), which is strong on naval architecture and gives so much marine engineering as may be. A logical arrangement would be to teach the elements of the entire profession to all students of shipbuilding and allow specialization in either naval architecture or marine engineering.

The American Society of Naval Architects

IT is reported that the American Society of Naval Architects and Marine Engineers contemplates changing its name and appearing hereafter as the American Society of Naval Architects. Incidentally, there will be the advantage of a briefer title, should the change be made, but the real reason is that the science and art of shipbuilding, including all branches and details, should be unified, and that the members of the profession should be conscious of their essential duty. Such a result, if it can be accomplished, is greatly to be desired.

There is considerable confusion in the popular mind concerning the designation of experts engaged in the science and art of shipbuilding; those conversant with the matter know that a naval architect designs ships and that marine engineers have to do with the engines; also that a naval constructor is a commissioned officer of the navy who designs and superintends the construction of naval vessels. When we had an engineering corps for the navy the naval engineer had to do with the engines of warships. Since the line officers of the navy, or certain of them, have taken over the duties of the engineering corps, the term naval engineer has a tendency to become obsolescent.

Now the greater part of marine engineers are seagoing engineers; the marine engineer par excellence is the designer of marine engines and is the running mate of the naval architect. Not infrequently he is versed in naval architecture. Consequently the chance of confusion from the use of the term marine engineer is unfortunate. There was a time when the naval architect had the same relation to the shipwright that the architect had to the house carpenter. The name naturally implies a similarity that no longer exists, and adds to the chance of popular confusion.

The several terms may be associated by the following form:

$$\left.\begin{matrix}\text{Naval}\begin{cases}\text{architect}\\ \text{constructor}\\ \text{engineer}\end{cases}\\ \text{Marine engineer}\end{matrix}\right\}$$

If we make a permutation of the two first terms and the three last terms, there are six possible combinations, of which four are proper, leaving two that are improper, namely, marine architect and marine constructor. It is curious how often the first mistake is made even by intelligent, well-informed men who have a real interest in shipbuilding, although the term marine constructor seldom appears.

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NEW BOOKS

Hot Bulb Oil Engines

REVIEWED BY C. H. PEABODY, DR. ENG.

HOT BULB OIL ENGINES AND SUITABLE VESSELS. By Walter Pollock, M. I. N. A. Size, 6 by 8¾ inches. Pages, 430. Illustrations, 441. New York, 1920: D. Van Nostrand Company. Price, $10.

There are two main classes of internal combustion engines: (1) those using a fuel which, like gasoline, can be vaporized in a carburetor, and (2) those that use oils that must be sprayed into the cylinder and largely, if not entirely, burned in the fluid condition. In America, gasoline motors found ready favor and were but little restricted, but in England both the Admiralty and the Board of Trade disliked gasoline and attention was directed to heavier oils, which are less dangerous and also less expensive. The pioneer work up to 1890 was done by the Priestman and the Hornsby-Akroyd engine companies; they used oils heavier than gasoline, which were vaporized in a separate chamber before entering the cylinder. This hot chamber has been standardized as a hot bulb into which the oil is sprayed at or near the end of the compression stroke and where it is partially vaporized and partially burned as finely divided fluid. This process is likely to crack some of the oil and the carbon is liable to form a hard, adhering incrustation. Provision must be made for removing this carbon at intervals. Starting a little later, but paralleling the development of the hot bulb engine, the Diesel engine by its superior economy of fuel has received favor for use on large vessels, but has not been put on the market in small sizes. The hot bulb engine can be had in all sizes and its less weight and cost, together with the advantage of easier management, has led to its wide adoption, especially in Europe. It deserves more favor than has been accorded it in America, and the present volume is well calculated to work toward that end, as it covers the field well, is excellently illustrated and is not too technical.

Though started in England, the best development of the hot bulb engine has been in Sweden, but it is made in nearly all industrial countries, i. e., Denmark, Norway, Holland, France and America, where it has had to struggle against the gasoline engine already well established. Germany gave most all attention to the Diesel engine.

Like all internal combustion engines, except the Diesel, the hot bulb engine is made to work on the two-stroke cycle or the four-stroke cycle, and like all such engines the four-stroke engine meets with the most favor.

The author illustrates thirty-six makes of hot bulb engines from all the seven countries named, from which may be had a good idea of the essential features of the engine and the various ways of fulfilling the necessary conditions. He gives special attention to forms applicable to marine propulsion and to the larger sizes for that purpose. He quotes the development of 150 horsepower per cylinder in practice and thinks that 250 can readily be obtained; this latter power per cylinder can be applied to the bulk of freighters provided twin screws and multiple cylinders are used as in Diesel practice.

A marine engine of whatever power must be reversible. Trivial boats may use reversible propellers, moderate powers may be reversed with gearings, but large engines must be reversed directly. Two-stroke engines can all be reversed by pre-ignition. This is familiar enough for small engines, but it may not be generally known that it is applied for all sizes and is customary with the Swedish Bolinder engine. The engine is slowed by diminishing and then interrupting the oil supply and is usually unclutched. Oil is injected before the piston reaches the top of the stroke, whereupon the engine reverses and the clutch may be thrown in. The Bolinder engine has been thoroughly tested by reversing without unclutching. Large four-stroke engines are commonly reversed with compressed air and the gear for that purpose has some complication. It is claimed that an oil engine can reverse quicker than a steam engine.

The essential feature of this type of engine is the hot bulb, to which the author gives special attention. In all cases the bulb must be heated by a special lamp before starting. It remains hot during action at full power, but must be either heated or provided with some special device when the engine is running light. It is best made of cast iron and may last several years. A variety of forms and devices are shown. Closely connected with the bulb and essential to its action is the apparatus for fuel injection, including the fuel pump and the governor, which acts directly on the fuel supply. Some engines for vessels have gear for regulating the fuel supply carried up to the deck. In general, the engine, whether stationary or marine, is started without load and has a clutch which may or may not be associated with a reversing gear. Small engines can be started by swinging the flywheel, throwing into action a starting cam, which reduces the compression, as is common with all internal combustion engines. Large engines should have some form of power starting gear. Compressed air is the best form and may, of course, be used also for reversing.

The author's treatment of propellers is superficial, as it must be in a book covering so wide a range. It is judicious except as he gives a simple diagram for determining dimensions of propellers, a matter that cannot be dealt with so simply. He is right in urging standardization of engines and propellers. The ships should be standardized at the same time.

The author has a chapter on the financial advantage of oil engined ships over steamships using coal; he properly considers that when an oil engine can be used the combination of oil and steam is a half-hearted compromise. On large ships for passenger service or war he concedes the necessity of using steam (probably in turbines) for some time. He gives an example of relative costs of power for a certain ship with (1) a hot bulb engine, (2) a steam engine and oil burned under the boiler, and (3) a steam engine with coal. It is not unlikely that something like the advantage he claims for the hot bulb engine can commonly be obtained, but any such comparison is likely to change in a marked manner with change of time and place, and the present is a most uncertain time.

A long chapter is given on the application of hot bulb engines to all sorts of craft, mostly of small or moderate size, though he mentions an American tanker carrying 5,000 tons and having three sets of engines of 500 brake horsepower each. In his list are small freighters, coasters, tugs, lighters, trawlers, dredgers, lifeboats, tropical and arctic vessels and all sorts of yachts and houseboats. If any criticism of his illustrations is proper, we may question the advantage of showing so many examples, many of which are similar.

The author is of the opinion that an engineer who really knows his hot bulb oil engine will agree that it is the simplest engine he has ever seen and he would never think of going back to steam. Also he thinks that engineers can be more easily and quickly trained than for any other engine. From the simplicity of the engine few troubles are to be anticipated, though he admits that troubles will

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occur. Directions are given for preparations for starting and stopping, and for running, including maneuvering and running lights. A useful table gives the periods after which certain parts of the engine should be opened, cleaned and inspected, ranging from one month for fuel filters to a year for cylinder jackets and fuel pumps. Hints are given concerning the installation of engines and accessories; they are intended rather for the engineer of the ship than the designer, though the latter may find an advantage from looking at things from the engine driver's point of view.

Auxiliary machinery for hot bulb engines has not received the attention deserved, and the final chapter of this book on that subject is therefore the more important. The author names nine classes of such machinery, all but two being imperative on ships of a thousand tons, i. e., steering gear, cargo winches, windlasses, electric lights, wireless, bilge pumps, ballast pumps, discharge pumps for tankers, and compressed air. He sets aside the steam donkey boiler as undesirable on an oil-engined ship, and discusses three ways of dealing with auxiliary machinery: (1) separate oil engine, (2) electric generator sets, (3) connection with the main engine by connecting rod, belt, chain or gearing. If an air compressor is found on a ship it may be taken as the source of power for some of the machinery, especially as the customary deck gear and pumps need little alteration for using air instead of steam. Steam is well adapted to working windlasses and winches, as they can be designed to stall under excessive load without breaking the lines. Of course, compressed air has the same property. Now that electric drives for auxiliary machinery are becoming standardized, a designer may well decide to install a sufficient hot bulb electric plant and use it for working all the auxiliaries. Some auxiliaries may advantageously have their own engines. Connection by any means to the main engine is of doubtful advantage to auxiliary machinery; perhaps an exception can be made for bilge pumps either regular or emergency. The hot bulb engine appears to be well adapted to auxiliary machinery for sailing vessels, in place of the gasoline engines that have long been in use on our coast.

Old-Time Ships of Salem

OLD-TIME SHIPS OF SALEM. By Robert S. Rantoul and William O. Chapman. Size, 9 by 11 inches. Pages, 70. Illustrations, 16 colored, 19 black and white. Essex Institute, Salem, Mass. Price, $3.

To those who are interested in the start of things as well as their development to their present stage, this unique publication will prove a treasure. It tells graphically and with the force of brevity how the hardy mariners of the late 1700's and early 1800's took their full-rigged ships of less than 100 feet in length, and often less than 300 tons burden, on cruises to the uttermost reaches of the globe, taking as a matter of course labors and dangers which would be regarded as hair-raising "stunts" in these days when a 12,000-ton ship, propelled by steam and electricity, is nothing to excite comment.

And they brought back to the "Wild New England Shore" freights which laid the foundation of more than one of the down east fortunes of the present, as well as giving good returns to the men who manned them, most of whom had an interest in the ventures, however small.

The little book is crowded with stirring narratives of the old days, the authors were well acquainted with their subject, and the Essex Institute is to be congratulated on having published a work which is historically, typographically and pictorially a thing to be treasured.

The Dreadnought

THE DREADNOUGHT OF NEWBURYPORT, MASSACHUSETTS. By Francis B. C. Bradlee. Size, 6½ by 9 inches. Pages, 28. Illustrations, 7. Salem, Mass., 1920: The Essex Institute. Price, $1.

Perhaps the most famous of the Liverpool packet ships, which made maritime history in the days before steam and the Civil War put them out of business, was the *Dreadnought*, which, built in Newburyport by Currier & Townsend in 1853, made, under command of her equally celebrated skipper, Captain Samuel Samuels, the record voyage of 9 days and seventeen hours from Sandy Hook to where she was taken up by a Queenstown pilot. This little brochure is a valuable addition to the lore of the days when "a wet sheet and a flowing sea" were the ideal conditions for making speed, as in addition to the story of the *Dreadnought's* exploits there are sketches of other ships of her time which add to its interest.

It is neatly printed, with a heavy paper cover of dark blue, and one page is given over to the *"Dreadnought"* chantey, which has a prominent place in the songs of the sea that are now seldom used and are almost forgotten except by the oldest of "old salts."

Steamship Coefficients

REVIEWED BY C. H. PEABODY, DR. ENG.

STEAMSHIP COEFFICIENTS, SPEEDS AND POWERS. Charles F. A. Fyfe, M. I. N. A. Size, 4 by 6 inches. Pages, 390. Plates, 68. Tables, 45. London, 1920: E. & F. N. Spon, Limited. Price, $7.50.

In this compact volume the author has brought together and arranged for use all the information extant bearing on the important matter of speed and power of steamships, matter which is scattered through half a century of scientific publications and in the proceedings of learned societies, and in particular the societies of engineers and shipbuilders of Great Britain and America. All of this is assembled by the aid of the theory of mechanical similitude, and examples are worked out in detail. For convenience of the computor, tables of integral, fractional and mixed powers of numbers are given, and also extension tables, from which the computor may select or interpolate results instead of making special computations.

The author presents with considerable detail the results of experiments in towing tanks as given by the Froudes, by Admiral Taylor, Colonel Rota, Mr. G. S. Baker and Professor H. C. Sadler and Mr. W. J. Luke. He states the methods of presenting results used by the Froudes, but prefers Admiral Taylor's method of giving the residual resistance in pounds per ton displacement. He gives reproductions of Froude's diagrams for propellers and applies them to numerous problems for finding dimensions and proportions.

Nearly half of the book is devoted to tabulating miscellaneous data gathered from all sorts of sources, and this part of the book gives evidence of extreme haste, throwing together results of trials of ships in detail, assembled tables of coefficients from various ships, statements of evidence and opinions on mechanical efficiency of engines, thrust block friction, resistance of bilge keels and other appendages and the like. Unfortunately, the index is incomplete, so that information is difficult of location.

CORRECTION.—In the letter on "Method of Estimating Steel Hull Weights" published on page 774 of the September issue, a typographical error occurs in the last line of the next to the last paragraph, where the coefficient should be .30 instead of .03 as printed.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY JAMES L. BATES

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Rules for Fuel Oil Piping

Q. (1101).—Will you please let me know what are the rules for fuel oil piping, according to the requirements of the United States Supervising Inspectors and Lloyd's Register. I understand that according to United States rules if oil is carried above the tank top, gate valves should be fitted inside the tank and operated from deck; also steam valves for trimming pump and service pumps to be operated from deck, but I am not able to find a written rule for it. M. V.

A. (1101).—The recognized classification societies do not lay down detailed specifications for fuel oil piping systems, but rather fix certain basic principles and require the submission of the piping layouts developed in the individual case for approval. The United States Steamboat Inspection Rules cover the matter in the same way. Thus it is apparent that the details become to a certain extent matters of judgment with the inspectors, modified by the recognized practice in a given locality.

Model Experiments in Running Stream of Water

Q. (1103).—I shall appreciate it highly if you will kindly inform me what has been done experimentally, or otherwise, in the way of making model experiments in a running stream of water, instead of the usual "tank" experiments relating to "towline pull," etc. It appears to me that a model could be suitably mounted in a trough of rectangular or semicircular section, through which water could be flowed by means of a centrifugal or propeller type of cheap pump (passing suitable guides, of course, before coming into contact with the ship to give practically straight stream lines), from which many useful measurements and much useful data could be obtained, at a fraction of the capital investment for apparatus and housing that the usual "naval testing tanks" cost. No doubt this matter has been considered, and possibly tried, but I do not remember seeing descriptions or articles upon this subject, and so shall be pleased to hear where I can find such. Possibly you have published such. F. W. S.

A. (1103).—The flow of water past a fixed object or model has been utilized in England, Germany and the United States for the investigation of problems of resistance and propulsion. After a certain amount of experimentation, this method of investigation was discontinued in this country in favor of the usual or still water method. Information relative to the German work along this line is not available.

The British national experimental tank, placed in service in 1910, has as part of the equipment a small tank having a breadth of 5 feet and a depth of 3⅛ feet throughout its uniform section. The length of uniform section is 31½ feet. The tank is built of reinforced concrete and is intended for use either with still water and moving model or with flowing water and fixed model. In the latter condition it is supplied by a 2½-foot rotary pump capable of delivering 75 cubic feet per second and designed to give a water velocity of 3 miles per hour. An 80-horsepower motor is used to drive this pump. Provision is made for maintaining the water at a constant temperature.

"This small tank is intended for general laboratory experiments and for more or less exploratory work with models."—(From paper by G. S. Baker, referred to below.)

The practicability of any experimental tank depends largely upon the facilities which it affords for the carrying out of the various investigations desired. Among the usual investigations may be mentioned the following:

(1) The resistance of ship forms.
(2) The resistance of ship appendages.
(3) The efficiencies of ship propellers.
(4) The effect of waves on the resistance of ship forms.
(5) The rolling of ships among waves.
(6) The effect of shallow draft upon the resistance of ship forms.
(7) The erosive effect of propeller action upon the beds of shallow channels.

It is evident that for purposes (1), (2) and (3) either still or flowing water could be used satisfactorily under proper circumstances. For (4) and (6) the still water method appears to have advantages, and for (5) and (7) it would seem difficult to adapt the flowing water at all.

There are also certain difficulties in connection with the flowing water method which would have to be overcome in order to make it of general use. Principal among these may be mentioned the following:

The great size of pump and motor required to secure a satisfactory flow of water at a speed of 6 or 7 miles per hour through a tank having a width of, say, 30 feet and a depth of water of 12 feet (such dimensions and speeds have been found to give satisfaction with the sizes of model which appear necessary in order to secure accurate results).

The floor space required for such an installation.

The difficulty in so baffling and deflecting as to secure water of uniform speed throughout its mass when approaching the portion of the tank in which the model is fixed.

Information in some detail relative to the small British tank referred to above may be obtained by consulting papers read by Mr. G. S. Baker before the Institution of Naval Architects, April 5, 1911, and March 29, 1912.

A description of our own model tank and the methods employed there may be found in "Naval Construction," by R. H. M. Robinson.

Stern Anchors

Q. (1104).—We should be much obliged if you can give us some information with regard to vessels having a windlass on the poop aft and anchors in hawse pipes at the stern. We understand that this arrangement is sometimes provided and are anxious to get particulars of same.

A. (1104).—This question, as stated, is very definite, making inquiry relative to stern anchors (plural). Replying to it on the basis of its exact wording it may be said that comparatively few instances of the fitting of more than one stern anchor have been noted by the writer.

If it is assumed that the inquiry covers installations of single stern anchors also, it is suggested that the party be referred to:

(1) The Federal Shipbuilding Company, Kearney, N. J. The general plans of the 9,650-ton deadweight general cargo vessel prepared by this company show a stern anchor in hawse pipe and apparently handled by a wildcat fitted on the gypsy shaft of the after winch.

(2) The Bethlehem Shipbuilding Corporation, South

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Bethlehem, Pa. The general plans of a 12,000-ton deadweight tanker built by this firm show anchors stowed aft on the upper deck. In this case, however, hawse pipes are not provided. The anchors are probably handled by a cargo boom.

The general plans of the Hog Island type-B ship show such an anchor and hawse pipe, but do not give the detail desired.

Interpreting the question still more broadly, it may be stated that there is no clearly defined practice relative to the use of stern anchors. The Germans have used them in many of their large naval vessels. On these ships a single anchor carried in a hawse pipe well aft, either at the side or on the centerline, has frequently been fitted. The British have followed a similar practice in such vessels as the *Eagle* and *Argus, Furious, Courageous* and *Glorious,* as well as in some light cruisers and monitors. Most of the capital ships in the United States Navy carry small stern anchors weighing 5,000 or 6,000 pounds. They are not, however, carried in hawse pipes, but are stowed on deck and handled by means of crane or davit. In some of the United States gunboats, stern anchors are carried stowed on chocks on the weather deck aft. In such cases a collapsible anchor crane has frequently been fitted, so located as to plumb the stowage position, and of such outreach as to swing the anchor well clear of the vessel's side.

Pressures at Various Compressions of a Spring

Q. (1106).—Please give formula and calculation for the pressures at various compressions of a spring; that is, at what pressure will a safety valve spring release at various points of compression? Assume a spring made of ⅜-inch round steel; inside diameter, 1 1/16 inches; outside diameter, 1 13/16 inches; height of spring not under tension, 6½ inches; number of coils, 12. At what pressures will it release by ¼-inch compression? A. O. M.

A. (1106).—The pressure required to produce any given deflection in a cylindrical helical round bar spring is expressed by the following formula:

$$P = \frac{fTd^4}{8D^3n},$$

where

P = pressure in pounds.
f = deflection in inches.
T = torsional modulus of elasticity in pounds per square inch.
d = diameter of wire of spring in inches.
D = mean diameter of coil in inches.
n = number of coils.

The deflection of the spring in the above problem will depend upon the value used for T, which is variously given from 10,000,000 to 14,000,000 pounds per square inch. Assuming a value of 12,600,000 pounds per square inch, as given by "Machinery" for steel, then, since D = 1 1/16 inches + ⅜ inch = 1 7/16 inches,

$$P = \frac{\frac{1}{4} \times 12{,}600{,}000 \times (\frac{3}{8})^4}{8 \times (1\ 7/16)^3 \times 12} = \frac{12{,}600{,}000 \times (3)^4 \times (16)^3}{4 \times 8 \times (23)^3 \times (8)^4 \times 12} =$$

218.44 pounds.

It will be observed from the formula that for a given spring T, d, D and n are constants. P, therefore, varies directly as f; hence, P equals a constant times f and may be written $P = cf$, where $c = \frac{Td^4}{8D^3n}$ and $QP = Qcf$, where Q is any factor, either integral or fractional. Hence for any other deflection than ¼ inch, as $Q \times \frac{1}{4}$, the required pressure to produce that deflection will be $Q \times 218.44$.

It will also be noted that neither the free height nor the solid height of the spring appears in this formula. If, now, we let h equal the solid height of the spring, i. e., the height when all the coils are compressed together, then

$$h = nd \text{ and } n = \frac{h}{d}.$$

Substituting this value of n in the formula gives $P = \frac{fTd^5}{8D^3h}$. This formula, with a change in notation, and all other formulae usually used in practice for cylindrical helical round bar springs are tabulated on pages 415 and 416 of "Machinery's Handbook," fifth edition (1915).

The derivation of helical spring formulae is given in various higher class text books, among which "The Strength of Materials," chapter XII, by Ewart S. Andrews, B.Sc.Eng., and "The Elements of Mechanics of Materials," chapter IV, by C. E. Houghton, A.B., M.M.E., are especially recommended.

Feeding Boiler by Injector

Q. (1100).—In a tug of about 200 indicated horsepower, the feed pump broke down and it was necessary to feed the boiler by an injector which could just do the work, taking the water from the jet condenser at the usual temperature. It was now, however, impossible to maintain the full steam pressure even by hard working. I should like to know the cause of this, as all of the heat with an injector returns to the boiler and I cannot assume that the losses by shock and friction in the injector are so considerable. D. K.

A. (1100).—The difficulty experienced in trying to maintain the original boiler pressure while feeding by means of the injector is due to the extremely low efficiency of the injector when judged simply as a pumping device. The steam consumption in the case of the injector may be considered as roughly four times that required by the ordinary feed pump when furnishing the same amount of feed water as the injector. A partial explanation of this difference lies in the fact that, while the injector is subject to but very small heat losses, its operation involves the imparting of the energy stored in a relatively large steam supply, in the form first of high velocity and then of pressure, to a small jet of water. During the process the steam supplied is condensed and returned to the boiler as water, where it must be transformed again to steam. The low efficiency of the direct acting pump ordinarily used for boiler feed purposes becomes negligible if the exhaust steam is all applied to heating the feed water.

For further information on this and related subjects, your attention is invited to "Practical Marine Engineering," by C. W. Dyson (7th edition), pages 443 to 448 inclusive, also to "Mechanical Engineer's Pocket Book," by Kent, under the subjects of "The Injector," "Boiler-feeding Pumps," etc.

Evaporation of Lubricating Oil

Q. (1051).—I should like to know the amount of evaporation which would occur when 1,500 gallons of lubricating oil are heated to 180 degrees F. for 24 hours. The grade of oil is Vacuum oil D. T. E. extra heavy, 25.3 degrees Baumé, .905 specific gravity, 7.509 pounds per gallon. J. H. A.

A. (1051).—Unfortunately the maximum evaporation loss is not often stated in lubricating oil specifications, although for transformer oils it is important. A certain mineral lubricating oil of .88 specific gravity lost .06 percent of its weight when heated to 212 degrees F. for five hours. At lower temperatures the loss would be considerably less, also the evaporation loss per hour decreases the longer it is heated. In a turbine gear casing the conditions are likely to be different from a watch glass containing oil and placed in an oven. The leakage loss is probably more than the loss by evaporation in a gear casing.

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PERSONAL MENTION

WILLIAM CHISHOLM is to succeed A. J. Frey as head of the Construction and Repair Division of the Shipping Board on the Pacific Coast. Mr. Frey has retired from the Board to accept a position with a private company.

WILLIAM H. MCGEE, of William H. McGee & Company, New York City, has been named national councillor of the National Board of Marine Underwriters to represent this organization in the Chamber of Commerce of the United States. For some time past Mr. McGee has held this position in the Chamber of Commerce, which is made up of representatives from more than 1,300 commercial and industrial organizations. The function of the council of the Chamber on which Mr. McGee will serve is to determine the programme and appoint nominating committees for the annual convention. Each councillor also acts as chairman for the members of the delegation representing his particular organization.

William H. McGee

J. W. LINCK, assistant to Robert L. Hague, former chief of the Division of Construction and Repair of the Shipping Board, is now with Victor S. Fox & Company.

CHARLES WHITING BAKER has recently announced his retirement from engineering journalism, in which field he has been connected with the *Engineering News-Record* since 1886. Under his direction the Engineering Business Exchange, 30 Church street, New York, has been organized for the purpose of bringing together those desiring to sell or purchase engineering or technical business properties. Mr. Baker graduated from the University of Vermont in 1886, in which year he became associate editor of the *Engineering News*. At various periods since that time he has been editor-in-chief and consulting editor of the journal and vice-president and director of the Engineering News Publishing Company. He is a member of the American Society of Mechanical Engineers and at the present time vice-president of the American Society of Terminal Engineers. Since 1915 he has been a member of the Engineers' Club, New York City, and since 1917 a member of the Engineering Council, representing the American Society of Mechanical Engineers. He has also been prominent in public affairs.

Charles Whiting Baker

CAPTAIN M. S. HARLOE, formerly a lieutenant-commander in the United States Navy in command of a naval transport, has been appointed agent of the United States Shipping Board division of operations in Japan.

C. D. KENNEDY, district agent for the Division of Operations of the Shipping Board, Portland, Ore., has resigned to take the position of Portland agent for Norton, Lilly & Company.

LIEUTENANT-COMMANDER WILLIAM L. VALE DAYO, U. S. N., has recently been appointed aide to Rear Admiral Samuel Robison, commandant of the Charlestown Navy Yard, Charlestown, Mass. He was formerly in command of the destroyer *Morris*.

G. BRONSON PHILHOWER, JR., is now with the Reading Iron Company, Reading, Pa., in its New York sales department. Mr. Philhower has had extensive training in related fields—the technical publishing business in New York, automobile and tool steel sales work, and, during the war, the mechanical division of the Navy, Mr. Philhower being attached to the aviation and submarine chaser divisions. His sales experience has been supplemented by an intensive course of training in the various plants of the Reading Iron Company, whose apprentice course Mr. Philhower entered in February, 1920. After having worked in various capacities and gained a detailed knowledge of the manufacture of wrought iron pipe, Mr. Philhower was appointed salesman, with headquarters at the Reading Iron Company's New York office, 99 John street.

G. Bronson Philhower, Jr.

H. A. NOBLE, vice-president of the Pittsburgh Spring & Steel Company, Pittsburgh, Pa., has been elected president to succeed D. C. Noble who died recently. S. F. Krouth, secretary and assistant treasurer has been elected vice-president and treasurer, with headquarters at Pittsburgh. J. N. Brownrigg, eastern sales agent in New York, has been elected vice-president and eastern representative, and F. Ryan, western sales agent at Chicago, has been elected vice-president and western representative, with headquarters in Chicago.

MARTIN J. GILLEN recently announced his resignation as a member of the Board of Trustees of the Shipping Board Emergency Fleet Corporation and as special assistant to the chairman. In his work with the Shipping Board as assistant to Chairman Payne and later to Chairman Benson, Mr. Gillen gave most of his attention to the settling of claims growing out of the cancellation of war contracts. It is reported that Mr. Gillen will succeed Swager Sherley as director of finance with the Railroad Administration under Director General John Barton Payne.

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Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

PRESIDENT NULLIFIES SECTION 34 OF MERCHANT MARINE ACT

Declares Congress Encroached On His Prerogatives and Exceeded Its Powers In Ordering Abrogation of Classes In Commercial Treaties

Official announcement was made on September 24 by Secretary of State Colby that President Wilson had decided not to give notice of the abrogation of certain clauses of commercial treaties as provided in the new Merchant Marine Act.

The Act directed the President to give notice within 90 days after the passage of the Act that the treaties in question would be terminated. More than twenty nations were affected and numerous protests already have been made by some of them. The 90 days expired on September 4.

Secretary of State Colby in making the announcement made it clear that the President's decision with reference to the instruction given in Section 34 had no bearing upon other provisions in the Merchant Marine Act. The other parts of the law remain in effect, and the President in the near future plans to appoint members of the Shipping Board provided by the Act.

The formal statement issued by the State Department announcing the President's stand follows:

"The Department of State has been informed by the President that he does not deem the direction, contained in Section 34 of the so-called Merchant Marine Act, an exercise of any constitutional power possessed by Congress.

"Under the provisions of the section referred to, the President was directed within 90 days after the Act became law, to notify the several governments, with whom the United States had entered into commercial treaties, that this country elected to terminate so much of said treaties as restricted the right of the United States to impose discriminating customs duties on imports and discriminatory tonnage duties, according as the carrier vessels were domestic or foreign, quite regardless of the fact that these restrictions are mutual, operating equally on the other governments which are parties to the treaties, and quite regardless also of the further fact that the treaties contain no provisions for their termination in the manner contemplated by Congress.

"The President therefore considers it misleading to speak of the 'termination' of the restrictive clauses of such treaties. The action sought to be imposed upon the Executive would amount to nothing less than the breach or violation of said treaties, which are 32 in number, and cover every point of contact and mutual dependence which constitute the modern relations between friendly States. Such a course would be wholly irreconcilable with the historical respect which the United States has shown for its international engagements and would falsify every profession of our belief in the binding force and the reciprocal obligation of treaties in general."

Secretary Colby, commenting on the point made by the President that Congress had exceeded its powers, called attention to the veto by President Hayes of an act passed by Congress in 1879, which required the President to give notice to China of the abrogation of Articles V and VI of the Burlingame treaty. President Hayes declared that "the power of making new treaties or of modifying existing treaties is not lodged by the Constitution in Congress, but in the President, by and with the advice and consent of the Senate, as shown by the concurrence of two-thirds of that body."

Continuing his statement, Secretary Colby says:

"The Merchant Shipping Act was approved June 5, in the final rush of the session's close, with no opportunity to suggest, much less secure its revision in any particular. To have vetoed the Act would have sacrificed the great number of sound and enlightened provisions which it undoubtedly contains. Furthermore, the fact that one section of the law involves elements of illegality rendering the section inoperative need not affect the validity and operation of the Act as a whole."

The action of the President follows protests against the Jones law by twenty-two distinct nations, all of whose interests are seriously affected by it. England, France, Norway, Sweden and Denmark made the most violent protests.

It has been pointed out in shipping circles that, coming at a time when the interests of Great Britain and Japan are effecting a combination for a marine war upon the United States, and Norway, Sweden and Denmark are planning to impose discriminatory rates against American ships, the President's decision robs the Shipping Board of all its powers of retaliation and even of defense.

NEW ENGINE SAVES OIL

Bethlehem's Two-Cycle Marine Diesel Stands Sea Test

Charles M. Schwab, chairman of the Bethlehem Steel Corporation, gives credit to Arthur West, designer for the Bethlehem Shipbuilding Corporation, Ltd., for having perfected a marine Diesel engine which, with one-half the number of cycles in use on the present type of engine, can be operated with one-third the amount of oil generally used by ships with oil-burning steam machinery.

Mr. Schwab says the new engine is as far ahead of the present oil burners as the oil-burning ships are superior to coal-fired vessels, and that the new engine can be used on vessels of any size. Mr. Schwab, in his announcement, says:

"It is a great pleasure for me to announce that the Bethlehem Steel Corporation and the Bethlehem Shipbuilding Corporation, Ltd., have perfected a new two-cycle fuel-saving marine Diesel engine especially designed for American operating conditions, and adapted to land use as well as cargo vessels of any size. In the science and practice of marine engineering, this new engine represents a far greater advance over the oil-burning steamship than the latter is over the coal-fired steamship. It is also regarded as a signal triumph for American engineering skill in a field hitherto dominated entirely by Europeans.

"The development of the new Bethlehem fuel-saving Diesel engine represents two distinctive phases of advance in marine engineering.

"1 For the first time an internal combustion heavy oil engine for either marine or land uses has been perfected, which is not only designed and built by Americans but is built especially for Americans, and is adapted to American operating conditions.

"2. For the first time a two-cycle internal combustion heavy oil engine has been perfected which produces the same horsepower as a four-cycle engine practically twice its size, and is at the same time adapted to large cargo ships, while saving two-thirds in fuel cost alone, as

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compared with steam-driven oil-fired vessels.

"Neither of these developments is theoretically a new idea. For years Europeans have successfully operated large ships with Diesel engines. The achievement of Arthur West, the Bethlehem designer, who is at the head of our power department, is in the adaptation of the two-cycle engine to American operation and in its perfection for practical use in cargo vessels of any size.

"The success of this engine has already been demonstrated in two ways. It was installed and operated for ten months as part of the power plant of the Bethlehem Steel Corporation at Bethlehem, Pa. It was then installed in our new ore-carrying vessel, the *Cubore*, which has completed on regular schedule time, without a hitch, its first trip to Cuba."

FORTY-SEVEN CONSPIRACY CHARGES

Steamship Lines and Freight Brokers Indicted

Charged with being parties to a conspiracy in restraint of trade, in violation of the Sherman Anti-Trust Law, 38 steamship lines, 12 officers of the lines, 4 freight brokerage corporations, and 5 individual freight brokers were named in an indictment handed up to Judge William B. Sheppard in the United States District Court for the Southern District of New York on August 30 by District Attorney Francis G. Caffey.

The indictment, consisting of two counts, alleges a conspiracy between the freight brokers and steamship lines to keep all the freight brokerage business in the hands of the Steamship Freight Brokers' Association. It was alleged that 75 freight brokers, members of the association, handled 80 percent of the freight to or through the port of New York.

Pleas of not guilty were entered and bonds were given for appearance when summoned for a hearing.

177 Vessels Numbered in August

Eugene T. Chamberlain, Commissioner of Navigation, reports that 177 steam, sailing, gas and unrigged vessels of a total of 257,765 gross tons were built in the United States and officially numbered during August, 1920. Of these vessels, 67 of 257,738 gross tons, were metal craft, 48 of these, of 231,864 gross tons, being steamers.

Largest of the ships documented during the month was the *Golden State*, a passenger and cargo liner of 14,300 gross tons, built by the Newport News Shipbuilding & Dry Dock Company for the Shipping Board. Altogether 40 steamships, of more than 3,000 gross tons, are contained in the August enumeration.

During the month 27 vessels, of a gross tonnage of 22,248, were sold to British, Norwegian, Spanish and other foreign flags.

RAYMOND DEFENDS JONES

Answers Attacks on Marine Act Through Politics—Senator Renominated

H. H. Raymond, president of the American Steamship Owners' Association, 17 Battery Place, New York, came out early in the month with a strong reply to malicious political attacks on Senator Wesley L. Jones, the author of the Merchant Marine Act, declaring that attempts to undermine the Senator through foreign interference in American politics must be discredited.

That the attacks on the Senator were of no avail is shown by his renomination for a third term as United States Senator from the State of Washington by an overwhelming majority over his opponent, who was credited with having all the support Canadian and Japanese influence could bring to bear. President Raymond's statement follows:

"The rumor current in shipping circles here that foreign interests have raised a fund which is being devoted to the spreading of propaganda against Senator Wesley L. Jones and to an attempt to undermine him with the people is no surprise to me.

"The accomplishment of Senator Jones in securing the enactment of the Merchant Marine Act of 1920 is the greatest legislative step in behalf of an American merchant marine that has been taken in the past century. This legislation enables us to meet, if we wish, the handicaps which have been imposed upon us by similar legislation or by orders in council in other countries.

"Naturally shipping is a matter of international competition, and some of our foreign competitors are going to leave no stone unturned to defeat the objects of a measure so purely American. To seek to discredit a man who wields the influence of Senator Jones in shipping affairs would be a logical step in such a programme.

"Some foreign governments do not want to see us have a mercantile marine. So far as foreign trade is concerned they have had their wish in this respect for more than fifty years past. The American flag has been a rare sight in foreign ports. We have depended almost solely upon the vessels of other nations for the carrying of our shipping in foreign trade. When the war started in 1914 the United States was carrying but 10 percent of its own foreign commerce.

"Countries upon which this country had depended for transoceanic transportation became engaged as belligerents in the World War. Their vessels limited their cargoes to commodities essential to the prosecution of the war. There was an unusual demand for the products of all character of our manufactories, but our people could not avail themselves of this business because we had not the vessels in which to transport merchandise other than that specified by the governments of the belligerent countries. The period I refer to is previous to our own entrance into the war, of course.

"When in 1917 we did enter the war it became necessary for us to construct speedily a merchant marine. Without one we were almost helpless. Then we paid directly in dollars a part of the penalty for our having depended theretofore upon the merchant vessels of Germany, England, Japan and other countries.

"The United States has the vessels now and has an opportunity to develop and maintain an efficient American merchant marine, sufficient to handle our fair share of the world's carrying trade in foreign commerce and adequate for our needs as a naval auxiliary in time of emergency. The most far-reaching step in behalf of the permanency of such a fleet is the act for which Senator Jones is so largely responsible. We should see to it that foreign interests are prevented from discrediting this great piece of legislation and undermining Senator Jones, who stands out boldly for American shipping."

Twenty-Six Ships Delivered in August

The Shipping Board received from American and Japanese builders 26 steel ships during August, aggregating 219,075 deadweight tons, according to official government figures. The *Eastern Leader* and *Eastern Temple* were the Japanese contributions to the list. Only two of the 26 vessels were under 5,000 tons, while the majority ranged between 8,000 and 9,000 tons.

Perhaps the most significant event of the month was the delivery of the first combination passenger and freight liner out of 23 now building for the Government. The *Panhandle State*, a 13,000-ton steamer, was completed on August 30. The Hog Island fabricated steel plant finished the United States Army transport *Cantigny* and delivered her to the army authorities.

Fifteen steel steamers were launched by American shipyards for the Shipping Board—the largest being the 13,000-ton combination freight and passenger liner *Empire State*, by the New York Shipbuilding Corporation. The Kiangnan Dock & Engineering Company, at Hong Kong, sent the 10,000 deadweight ton oil-burning freighter *Celestial* down the ways, while the Moore Shipbuilding Company, at Oakland, launched the 10,000-ton oil tanker *Stockton*.

Cargo Ships and Tugs Sold

Sale of four vessels for a total of approximately $6,800,000 has been announced by the Shipping Board. Three tugs have also been sold for $80,000 each. The cargo vessels included ships assigned during the summer to various companies pending the adoption of the new sales policy, and the sales now announced are the result of closing negotiations following the adoption of the new policy.

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OIL BURNERS LEAD IN VESSELS NOW BUILDING

More Than 830,000 Tons of Tankers Under Construction Will Use Liquid Fuel—Only 7.4 Percent of Total Ships Building to Use Coal Exclusively

The rapidity with which oil is replacing coal as fuel in American shipping is strikingly shown in an analysis of the tonnage now under construction for private account in this country.

Figures prepared by J. B. Crowley, statistician for the American Bureau of Shipping, show that of the freighter tonnage now building no less than 78.1 percent is being equipped exclusively for oil-burning. Cargo carriers fitted to burn both oil and coal form 14.5 percent of the total, while those constructed to burn coal represent only 7.4 percent of the aggregate.

It is also interesting to note that the ships burning only oil and both oil and coal are much larger than those equipped simply for coal burning. The oil burners average almost 4,000 gross tons each, and the combination oil and coal ships almost 6,000 gross tons, while the coal burners are of an average of less than 2,000 tons, or less than half the size of the other types. The number of freighters of the various types and their aggregate gross tonnage are as follows:

Oil burners	101	400,455
Coal-burners	20	38,171
Combination	13	74,567
Total	134	513,193

All the fuel-consuming tankers under construction are oil burners. There are 121 of these, aggregating 830,064 gross tons, an average of almost 7,000 tons per tanker. Non-propelled tankers aggregate 19, of 11,991 gross tons, as compared with 109 non-propelled cargo carriers of 82,350 tons.

According to Mr. Crowley's compilation there were building for private account on September 1 a total of 383 vessels, aggregating 1,438,498 gross tons. The division, according to classification by the American Bureau of Shipping, Lloyd's Register of Shipping, those classed by both these societies and a fourth group, composed of vessels classified by other societies or being built without classification, was as follows:

	American Bureau		Lloyd's Register		Dual Class		Other or None	
FREIGHTERS	No.	Tons	No.	Tons	No.	Tons	No.	Tons
Coal	9	26,580	4	7,710			7	3,881
Oil	27	158,627	36	129,328	21	91,020	17	21,480
Both	3	17,653	6	32,484	4	24,430		
Non-propelled	8	4,500					101	77,850
Total	47	207,360	46	169,522	25	115,450	125	103,211
TANKERS								
Oil	24	165,255	71	513,833	16	122,238	10	29,638
Non-propelled			8	4,671			11	7,320
Total	24	165,255	79	518,504	18	122,238	21	36,958
Grand Total	71	372,615	125	688,026	41	237,688	146	140,169

It will be noticed that while the American Bureau exceeds Lloyd's Register in the number and tonnage of freighters under construction, the latter society has a considerably larger lead in the number and tonnage of tankers being classified, while the non-propelled vessels are chiefly with the smaller societies or are not receiving any classification.

Mr. Crowley's figures also show that of the total tonnage under construction for private account, 25.9 percent is with the American Bureau, 47.9 percent with Lloyd's, 16.5 percent is dually classified, and the remaining 9.5 percent is either with other classification societies or is not being classed.

CONSOLIDATION EFFECTED

New Organization of United American Lines

The executive and freight traffic departments of the United American Lines, formerly Livermore, Dearborn & Company, agents of the American-Hawaiian Steamship Company and the American Ship & Commerce Corporation, took possession of their new quarters at 39 Broadway, New York, on September 7. The personnel of the new organization follows:

W. Averill Harriman, chairman of the board; W. G. Sichel, assistant to the chairman.

Executive—Harris Livermore, president; E. C. Tobey, assistant; Henry Dearborn, vice-president; Victor H. Thun, controller; F. W. Anderson, secretary; C. M. Fedderman, treasurer.

Freight Traffic Department—C. J. Beck, general freight traffic manager; H. H. Garvin, assistant; E. W. Relyea, manager, and J. J. Gilbride, assistant, in charge of Mediterranean and long voyage trades; J. E. Waldorf, manager, and B. F. Gaede, assistant, in charge of Continental trades; H. J. Kehoe, in charge of coastwise trades; C. E. Barry, Western manager, Chicago.

Passenger Traffic Department—E. Lederer, director of passenger traffic.

Operating Department—J. D. Tomlinson, manager; H. M. Wesson and H. R. Hanlin, assistants.

TANKER PLANS APPROVED

Seventeen Vessels Under Way and to Be Built Cost $39,000,000

There have been approved by the Shipping Board plans for seventeen bulk oil carriers, aggregating 216,800 deadweight tons, under section 23 of the Merchant Marine Act, which provides for the exemption of excess profits taxes if the proceeds are invested in new tonnage in American shipyards. The vessels will cost approximately $39,000,000 at the present price of about $180 a ton for future delivery.

Fourteen of the ships are to be built by the Standard Oil Company of New Jersey, one by the Pacific Mail Steamship Company, one by the Sun Company, and one by the Vacuum Oil Company.

Two are exceptionally large, of 20,300 deadweight tons each. These are to be built by the Newport News Shipbuilding & Dry Dock Company for the Standard Oil Company.

The plans approved are as follows:

Pacific Mail Steamship Company, New York City, one 9,800 deadweight ton oil tanker, to be built by the New York Shipbuilding Corporation.

Sun Company, Philadelphia, one 12,800 deadweight ton single screw bulk oil steamer, to be built by the Sun Shipbuilding Company, Chester, Pa.

Standard Oil Company, New Jersey, fourteen oil tank steamers as follows: Three vessels, 15,100 deadweight tons, Federal Shipbuilding Company, Kearney, N. J.; three of 10,100 deadweight tons, Moore Shipbuilding Company, Oakland, Cal.; two of 10,440 deadweight tons, Sun Shipbuilding Company, Chester, Pa.; two of 20,300 deadweight tons, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; three of 11,740 deadweight tons, G. M. Standifer Construction Corporation, Vancouver, Wash.; one of 11,900 deadweight tons, Oscar Daniels Company, Tampa, Fla.

Vacuum Oil Company, New York City, one 10,000 deadweight ton tank steamer, to be built by the Moore Shipbuilding Company, Oakland, Cal.

In approving the plans of the vessels the Board decided that they should be constructed to meet the classification requirements of the American Bureau of Shipping, and has adopted this requirement as a condition of its approval required by the provisions of section 23.

Board Plans for Marine Week

Announcement was made at the Shipping Board on September 13 of its participation in the plans for the celebration of National Marine Week at Chicago, October 18-25. Admiral Benson stated that the purpose of the Board is to assist in arousing the interest of the country in the importance of shipping and especially to convince young men that the sea holds out promises for a profitable profession.

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NEW CONCERNS IN AUGUST

Capitalization of Shipping Companies Lowest So Far This Year

Shipping concerns organized in August, 1920, with an authorized capital of $50,000 or more, numbered twenty, as against eighteen in July. The aggregate capital of only $24,550,000, however, showed a decline compared with $26,250,000 for July, and a drop of more than 50 percent from the figures of August, 1919. The records kept by the *Journal of Commerce* show that the August figure is the smallest for any month so far this year.

During January-August of the current year the indicated investment in shipping and shipbuilding companies appears as $519,203,000, shipbuilding having attracted a far smaller proportion of the total than ownership and operation. The aggregate for the corresponding period of 1919 was only $196,786,000, the increase figuring out as well over 150 percent. As a matter of fact, this comparison does not bring out the impressiveness of the total for 1920 to date as does the statement that the largest aggregate for any year since the outbreak of the war, that for 1919, was but $323,613,000.

The average indicated investment per company in August figures out as $1,227,500, compared with $1,458,333 for July. For the other months of the year the average was as follows: June, $2,607,575; May, $999,469; April, $8,128,864; March, $2,945,237; February, $1,963,530 and January, $2,384,531.

Seven companies were organized in the month with an authorized capital of $1,000,000 or greater, as against only four in July. In June fifteen companies, with at least $1,000,000 authorized capital, were formed, a similar number being started in May. The record for the other months of the year shows thirteen concerns of such proportions organized in April, twelve in March, seven in February and ten in January, making the total for the first seven months of 1920, 76.

The following list comprises the names, States of incorporation and authorized capital of shipping companies organized in August, 1920, capitalized at $50,000 or more:

Brier Hill Steamship Co., Ohio	$1,000,000
Electric Steel Building Corp., Del.	600,000
Globe Line, Inc., Del.	2,000,000
Jarka, F. Co., Inc., N. J. (shipping)	100,000
Keans Transportation Co., Mass.	150,000
Lyn-dy-Shea Oil Transportation Corp., Del.	600,000
Lone Star Oil Transport Co., Md.	500,000
Liberian-American Steamship Co., Inc., Del.	500,000
Lysol, Inc., Del.	10,400,000
Northport Shipyard, Inc., N. Y.	100,000
North Atlantic Shipping & Agency Corp., N. J.	100,000
New York-Vistula Steamship Corp.	1,100,000
Pacific Packet Line, Wash.	1,200,000
Publicker Shipping Co., Del.	700,000
Service Line Corp., Del.	100,000
Slavia Transatlantic Corp., Del.	3,000,000
Seas Shipping Corp., Del.	100,000
Transo Steamship Corp., Del.	100,000
Trans-Shipping & Distributing Warehouse Corp., N. Y.	50,000
Winneton Shipping Co., Wash.	250,000
Total	$24,550,000

Air and Steam Drive Boiler Tube Cleaners

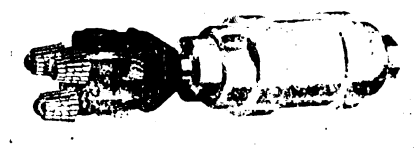
From time to time the matter of keeping boilers free of scale is brought to the attention of the industry, particularly after reports of the insurance companies indicate that explosions have been caused either directly or indirectly by the presence of non-conductors of heat on the tube walls. Not only must the tubes be kept clean to prevent possible explosions, but also to maintain every-day operating efficiency.

The mechanical means of removing scale has proved itself satisfactory over a long period of service, both from the point of view of economy and of positive action.

Some of the modern turbine-drive cleaners produced by the Lagonda Manufacturing Company, Springfield, Ohio,

Type No. 79 Cleaner for Curved Tubes

are typical in construction and operation of the best types of mechanical cleaners. Type No. 79, for example, is designed for use in 3¼-inch curved tubes of watertube boilers, such as the Sterling, Erie City, Maxim and Hyde types. This cleaner is constructed to remove the scale from the bends down to the iron, and, if properly operated, will not stall or have to be forced. The construction of this cleaner for either air or steam drive is such that



Type No. 80 Cleaner for Straight Tubes. Type No. 81 is Similar

a high rotative speed is imparted to the drive shaft by the impelling force delivered to four paddles enclosed in an elliptical case. Two of these paddles are always under pressure, so that there is no possibility of the cleaner becoming stalled if it is operated properly. The paddles bear against a hardened steel plate pressed into the main shell, which can be replaced when worn.

All wearing parts of the cleaners are high-carbon steel carefully tempered and ground. The rotor and center shaft are of one piece. An air or steam pressure of 80 to 100 pounds is required for most efficient operation, the consumption at this pressure being about 55 cubic feet per minute.

The quick-repair head and toggle joint are so arranged that they are most effective in removing scale from bends. Various other cutting heads may be used in combination with the toggle joint.

Another type of cleaner for straight tubes is also of interest. Nos. 80 and 81, for 3½-inch and 4-inch tubes, respectively, are especially adapted for use in the Heine, Babcock & Wilcox, Wickes, McNaull and similar type boilers. They may also be utilized in removing scale from economizer tubes and boiler feed water lines.

The motor in each case is similar to that described for Type No. 79 cleaner. A three-arm, quick-repair head is part of the standard equipment, as well as drill and porcupine heads, which may be used in combination with the toggle joint.

New Bedford to Have Lines for Carrying Cotton

New Bedford, Mass., which receives for use in its mills more than 2,000,000 bales of cotton a year, besides 200,000 bales for Fall River, is canvassing the possibilities of a proposal to establish its own steamship line to the cotton ports of the South.

A representative of the Massachusetts mill city has been over the ground at Savannah, New Orleans and Galveston, to ascertain what wharf space is available there, and is said to have secured an option on necessary berths.

Representations will be made to mill owners and managers at New Bedford regarding the economies to be effected through direct handling by sea of their cotton supply. At present the cotton comes by any available route, and with present traffic conditions deliveries are uncertain and cost of carriage high.

New Bedford has a new State pier well adapted to the needs of a cotton-carrying line, and such a line, with its freights assured, under proper management, ought to do well.

An example has been set to New Bedford in going into the coastwise steamship business by Norfolk, Va., which has established a line to take the place of the service abandoned by the Old Dominion Company, between Norfolk and New York, while Richmond, Va., is buying two ships to run to New York.

Japanese Lines Cannot Raise Passenger Rates

Passenger departments of steamship lines on the Pacific Coast have been notified that the Japanese Government refuses to permit Japanese lines to raise their passenger rates. The Japanese lines are subsidized and cannot raise rates unless granted permission by their government. The American lines cannot raise rates unless the Japanese do also.

The passenger conference some months ago decided to raise rates in proportion to expense of operation. The Toyo Kisen Kaisha and Nippon Yusen Kaisha, members of the conference, put in a request for permission to do this. It was not granted, and the Japanese Government said they should cut down their overhead. Passenger rates since the war began have increased only 25 percent across the Pacific.

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DeLamater-Ericsson Memorial Tablets

At the annual convention of the American Society of Mechanical Engineers last December, a memorial meeting was held on the evening of December 3 in commemoration of the eightieth anniversary of the arrival in the United States of Capt. John Ericsson and his fifty years association with Cornelius H. DeLamater in engineering work. In advance of the meeting it had been decided to erect memorial tablets to mark the sites of certain buildings which were closely identified with the work of DeLamater and Ericsson. It was proposed to erect four tablets as follows: One at the Phœnix Foundry at Laight and West streets, where the first screw-propelled vessel in this country was constructed, and where many other original developments were made; one at Capt. Ericsson's residence, 26 Beach street, where he designed the *Monitor* and made all his inventions during his later years; one at the DeLamater Iron Works at the foot of West Thirteenth street, where the engines of the monitors *Puritan* and *Dictator* were built, as well as the first submarine boat, the first torpedo boat, the first torpedo boat destroyer, the first self-propelled torpedo, the first air compressors, the first ice machines, and many other industrial appliances now in general use; and one at the Continental Iron Works, Greenpoint, L. I., where the hulls of the *Monitor* and other warships were built.

It is believed that there are many marine and industrial firms, organizations and individual manufacturers and engineers who, if given an opportunity, would contribute to the tablet fund, especially to commemorate the invention of the screw propeller and the building of the *Monitor*. Those interested are requested to communicate with the DeLamater-Ericsson Tablet Committee, H. F. J. Porter, chairman, Room 1100, Engineering Societies Building, 29 West Thirty-ninth street, New York City.

Navy Men Visit Westinghouse Plant

Eight lieutenant commanders and one senior grade lieutenant of the United States Navy recently spent a week in the plant of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa., studying manufacturing methods, with especial attention to marine apparatus in the process of construction. Besides the inspection visit through the plant, lectures were given to the navy men by engineers of the Westinghouse Company. The work which these men are doing is in connection with post-graduate work for a master's degree in engineering from the United States Naval Academy at Annapolis.

Mr. T. C. Allen, formerly comptroller of the Tacony Steel Company, has been appointed assistant to the president of the Penn Seaboard Steel Corporation.

HARRIMAN-KERR CONTROVERSY STIRS UP SHIPPING WORLD

Kerr Interests Control Ships Until October 24—Hamburg-American Deal Storm Centre—Millions More to Be Paid Before Matter is Settled—Benson Says Contract is All Right

When the Treasury Department seized $4,900,000 paid by the Harriman steamship interests for the stock in the Kerr Navigation Company held by H. F. Kerr and A. E. Clegg, on August 28, there started a contest which has developed into considerable magnitude, and stirred the shipping interests of the country to their limits.

The seizure, or rather sequestration, was ostensibly made with a view to looking after the tax interests of the Treasury in relation to excess profits, and Kermit Roosevelt, secretary and treasurer of the Kerr Steamship Lines, charged that W. A. Harriman, president of the American Ship & Commerce Corporation, inspired the seizure of the money, which was denied by Mr. Harriman. Then came the libel by American Ship & Commerce of the steamer *Kerlew*, operated by the Kerr Lines, and a temporary injunction restraining the operation of the libel.

Following this W. A. Harriman and R. H. M. Robinson, of American Ship & Commerce, and Ira A. Campbell, their counsel, were adjudged in contempt of court, but when they released the libel on the *Kerlew* no penalty was imposed under the contempt proceedings.

On behalf of the Harriman interests it was claimed that the Kerr Steamship Lines operated the ex-Austrian ships of the Kerr Navigation Corporation under a simple agency contract terminable at will. They charged that the Kerr Steamship Lines had failed to make an accounting at the end of each trip as required by contract; that they were from $200,000 to $350,000 in arrears; that they had used chartered Spanish tonnage on the Hamburg route while operating Kerr Navigation Corporation tonnage to South America, and that there were indications of secret profits and rebates.

Then Alfred E. Clegg issued a long statement reviewing the negotiations between the Hamburg-American and Kerr-Harriman interests, and charged that the contract between the American and German concerns was grossly inequitable and unfair to American shipping.

Rear Admiral Benson, chairman of the Shipping Board, later came into the quarrel, reaffirming his belief, announced when the deal first became known, that the agreement was a good thing, and that it did not provide in any way for a pooling of profits between the American Ship & Commerce and the Hamburg-American Corporations. The American Steamship Owners' Association republished the resolution passed in March last stating its opposition to any contract between an American concern and the Hamburg-American Line.

On September 16, Justice Lehman, in the New York Supreme Court, decided that the Kerr Steamship Company should be allowed to operate the vessels owned by the Kerr Navigation Corporation until October 24, after which all the vessels acquired by the Harriman interests may be operated by the owners.

The court action revealed that Alfred E. Clegg and H. Farquharson Kerr owned 75,000 shares of stock in the Kerr Navigation Corporation. In order to terminate the contract between the Kerr organizations, the Harriman interests must not only give ninety days' notice, but must purchase all of the stock held at $100 a share. Thus far only 49,000 shares of the stock have been purchased. Before the expiration of this period it will be necessary for them to pay over the additional $2,600,000 in cash. It has been announced that all of this money will be reinvested in new American ships.

The reason all of the 75,000 shares were not tendered for purchase on August 28 was that there are certain tax matters relating to 26,000 shares which had not been settled at that time.

Shipyard Receivers Appointed

Judge Manton, in the United States District Court, has appointed George Gordon Battle and Thomas B. Felder receivers for the National Shipbuilding Company, 42 Broadway, with shipyards at Three Rivers, Canada, and Violet, La., on application of Saul S. Meyers, representing creditors for over $1,000,000. An order of adjudication was also entered, and Seaman Miller was named as referee in bankruptcy. A petition in bankruptcy was filed against the company on August 21. Mr. Myers said that the liabilties were $5,000,000.

Shipping Board Loss on Concrete Tankers

Losses of more than $500,000 each were suffered by the Shipping Board in accepting the bids on the concrete tankers *Palo Alto* and *Peralta*, recently built at Oakland, Cal., in the opinion of shipbuilders. The Atlantic Refining Company, of Philadelphia, offered $825,000 for the *Palo Alto*, and the American Fuel Oil & Transportation Company, of New York, bid $700,000 for the *Peralta*. Two more of the concrete tankers are building at San Pedro.

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BUSINESS NOTES

The Mono Corporation of America announces the removal of its main office from Buffalo, N. Y., to 25 West Broadway, New York City, where a complete line of the automatic continuously recording gas analyzing instruments manufactured by this corporation will be displayed.

The Pennsylvania Pump & Compressor Company, of Easton, Pa., announces the opening of additional sales offices in the following cities: Buffalo, N. Y., J. B. Laird, manager; Cleveland, Ohio, L. J. Wakefield, manager; St. Louis, Mo., Corby Supply Company; Minneapolis, Minn., L. E. Pollard Company, and Omaha, Neb., L. E. Pollard Company.

The Uehling Instrument Company, 71 Broadway, New York City, manufacturer of fuel economy equipment, announces that it is now represented in the New England States by the Smith Engineering & Supply Company, 89 State street, Boston, manufacturers' agents and engineers, specializing in power plant equipment. S. W. Smith, president of the latter company, was until recently associated with the Uehling Instrument Company, with headquarters in the New York office.

The Walter H. Taverner Corporation, electrical and mechanical constructing engineers, have opened offices in the Flatiron building, 175 Fifth avenue, New York City.

The export department of the Oxweld Acetylene Company, which was formerly located at the company's factory in Newark, N. J., has been removed to the Carbide and Carbon building, 30 East Forty-second street, New York. The department has been reorganized and is now under the direction of Mr. R. G. Noble.

The Mesta Machine Company has opened an office in the Singer building, New York, from which point all its foreign business will be handled. All foreign correspondence should be addressed to the company at New York. The New York office will also be the sales office for the New York and Eastern States' territory. Mr. M. M. Moore, the export sales manager, who has just returned from a several months' European tour, will be in charge.

The Associated Business Papers, Inc., 220 West Forty-second street, New York, will hold a convention at the Astor Hotel, October 20, 21 and 22. The members of the general convention committee are F. M. Feiker, McGraw-Hill Company, chairman; David Beecroft, Class Journal Company; E. H. Ahrens, A. W. Shaw Company; Aglar Cook, *Electrical Record*; E. E. Haight, *Motor Age*. The national editorial conference has appointed H. C. Parmelee, editor of *Chemical and Metallurgical Engineering*, chairman of their committee, which will work with the publishers' general committee.

TRADE PUBLICATIONS

Twist Drills and Reamers.—In a catalogue issued by the Whitman & Barnes Manufacturing Company, Akron, Ohio, specifications of carbon and high-speed twist drills and reamers of all types are given.

Rivets.—A book containing useful information on rivets, intended for purchasing agents, engineers, draftsmen, shop foremen and others interested, has been issued by the S. Severance Manufacturing Company, Glassport, Pa.

Material Handling.—The Buffalo Hoist & Derrick Company has issued a pamphlet giving the specifications and a few of the uses to which the clamshell buckets, locomotive cranes, derrick and hoisting engines produced by this company may be put.

Turret Lathe Practice.—A reference book on vertical turret lathe practice in railroad shops has been issued by the Bullard Machine Tool Company, Bridgeport, Conn. The book is valuable as a reference for quick, efficient methods of setting up locomotive parts and performing the necessary machine operation.

Convert-A-Caps.—A pamphlet giving details of a new electrical connection plug cap has been issued by the Benjamin Electric Manufacturing Company, Chicago, Ill. Portable electrical appliances equipped with the new cap may be operated from almost any base board or wall receptacle of the slotted variety now in use.

Crane Comment.—The latest bulletin published by the Industrial Works, Bay City, Mich., contains the story of crane construction as carried out in Industrial Works shops. It also describes a variety of locomotive crane uses, both in wrecking work and new construction. A table of capacities, weights and radii, with different length crane booms, is also given.

Insulating Materials.—Recent interesting and valuable bulletins by the General Electric Company, Schenectady, N. Y., include Nos. 48704A and 48715, dealing respectively with insulating compounds and insulating fabrics. A wide variety of materials for both purposes are illustrated and described. Other bulletins are No. 49400 on the Hewlett link insulator, and No. 41311 on synchronous condensers.

"WEW" Valve and Steam Specialties.—A new edition of the illustrated valve catalogue and price list of William E. Williams, 62 Front street, New York City, is intended to show the most important and more widely used types of valves in stationary and marine engine practice. Information regarding special valves and brass and iron castings of any description will be furnished by this company on request.

Bundy Oil Separator.—Bulletin No. 1130, describing the Bundy Oil Separator produced by the Griscom-Russell Company, 90 West street, New York City, has just been issued. In it the construction and specifications of the separator are given, together with its application in steam turbines and reciprocating engine pipe lines. One feature particularly mentioned is the design of the baffle plates, which permits easy removal and replacement when cleaning is necessary.

Electric Drills.—The Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, is distributing a circular descriptive of Thor universal electric drills. A feature of this line is the size "00" portable electric drill with pistol grip handle, which is useful under a wide variety of conditions, including drilling, reaming, boring in wood, screw driving, etc. Other tools are adapted for grinding as well as drilling, and all are driven from ordinary lamp socket conections.

New Condulets.—Bulletin No. 100-N of the Crouse-Hinds Company, Syracuse, N. Y., describes a new series of condulets produced by this company which are known as the Mogul series. These particular condulets are designed to avoid kinking heavy wires or cables when pulling in or feeding them through a conduit system, and to afford ample space when making splices or taps. The condulets are made in eight types, each having eight sizes, ranging from 1 to 4 inches. Descriptions of the various types are listed in the catalogue.

McNab Encyclopedia of Marine Appliances.—This is a 206-page book, 9 inches by 12 inches, describing and illustrating the marine equipment produced by the McNab Company, Bridgeport, Conn. The book is primarily intended as a review of the latest developments in appliances and fittings for the construction and operation of ships. For convenience and reference, in addition to the general index, sectional indexes are given of appliances used by the hull, engine and electrical divisions as well as equipment used in navigation. The price of the book is $5.00, and it may be obtained from the McNab Company.

Spraguelets.—A catalogue describing conduit bodies produced by the Sprague Electric Works, New York, has just been issued. The principal features of this line of conduits are the knockouts and couplings which permit the assembly of conduit combinations that have not been possible with old tube bodies. The Spraguelet bodies are in three types and the couplings are designed for ½-inch and ¾-inch conduits, and are made to fit the one size knockout standard to all size bodies. Plates and covers for branch, deep and shallow body Spraguelets are listed and the entire line fully described.

Thermit Pipe Welding.—The thermit process of pipe welding as carried out by the Metal & Thermit Corporation, 120 Broadway, New York, is completely described in a catalogue recently made available. The pamphlet contains reports on successful tensile strength and vibration tests of thermit pipe welds conducted by the Stevens Institute of Technology. Among other tests described is one on 100 feet of 4-inch pipe which was ten years in service at West Albany, N. Y. This pipe was subjected to a hydraulic pressure of 1,500 pounds per square inch without revealing any defects.

Carbon Dioxide Equipment.—The Uehling Instrument Company, 71 Broadway, New York, has just issued bulletin No. 111 describing Style "U" Uehling carbon dioxide equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Among the features of the new machine are speedy action, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front indicator, which guides the fireman, while the recorder in the chief engineer's or superintendent's office makes a continuous record showing all changes in boiler adjustments conducive to either waste or economy.

Saving Lives at Sea.—Under this title the American Balsa Company, Inc., 50 East Forty-second street, New York City, has issued a booklet describing the necessity of equipping vessels with effective types of lifeboats, davits, rafts and other life-saving accessories. During the war many instances occurred when the lives of ships' crews and passengers were dependent on the efficiency of life-saving equipment. To a lesser extent in peace times a ship is dependent on this equipment, and so it must not be regarded in the light of minor outfitting to be left to the discretion of employees whose position compels them to place the question of a slight difference in cost ahead of the question of maximum safety. The booklet completely describes and illustrates various installations on cargo and passenger vessels, and takes up in detail the design of lifeboats, rafts, Welin quadrant davits and other life-saving devices.

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Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPBUILDING

Steamers, New York.—The Red D Line, it is reported, will ask for bids in October for two 280-foot steamers.

Tugs, San Francisco, Cal.—The Main Iron Works is constructing four tugs for the Ship Owners & Merchants Tug Boat Company.

Barkentine, Mahone Bay, N. S.—The Ernst Shipbuilding Company, Ltd., is building a barkentine, about 300 tons net, for private account.

Tankers, Oakland, Cal.—The Union Construction Company has a contract for three 8,400-ton oil tankers for the Anglo-Saxon Petroleum Company.

Lifeboats, Westville, N. J.—The Westvile Lifeboat Building Company has been incorporated, with a capital of $125,000, by Earl H. and Hagen A. Johnson to manufacture lifeboats, fittings, etc.

New Liner, North Vancouver, Wash.—The Wallace Shipyards will construct the new Canadian-Pacific liner that will replace the Princess Sophia, lost in 1913. The new ship will cost $1,000,000, it is said.

Tankers, Quincy, Mass.—It is reported that the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd., has a contract for four tankers for the Standard Transportation Company, New York.

Repairing Tanker, Brooklyn, N. Y.—The tanker John D. Rockefeller, which was sunk in Tampico Bay last December, is being repaired by the Robins Dry Dock & Repair Yard. The work will cost $750,000.

Pontoons, Brooklyn, N. Y.—W. H. Gahagan, Inc., is constructing ten wooden floating drydock pontoons with a lifting capacity of 2,000 tons each for the Emergency Fleet Corporation of the Shipping Board.

Tankers, New York.—The Atlantic Coast Shipbuilders' Association has received inquiries for two oil tankers for immediate delivery. Information will be supplied by the association, 30 Church street, New York.

Diesel Engines for Freighters.—Two freighters to be built by the Harriman Shipbuilding Corporation for the American-Hawaiian Steamship Company are to be equipped with Diesel engines to be built by the Cramps.

Six Vessels, Gulfport, Miss.—The Gulfport Shipbuilding Company has a contract for building six ships for the Government. The boats will be equipped with high-powered engines and outfitted with all modern facilities.

Tankers, England.—The Admiralty has issued orders for the construction of four additional oil-tankers in the National Dockyards, one each at Portsmouth, Devonport, Pembroke and Sheerness, at an estimated cost of £120,000 each.

Motorships, New York.—The Peruvian Steamship Company, 42 Broadway, is reported by the Guaranty Trust Company, 140 Broadway, to be in the market for four motorships of the Diesel engine type, of about 8,000 deadweight tons each.

Freighter, Vancouver, B. C.—The keel for a fifth steamer for "yard account" has been laid by Coughlan & Sons, and it will be of the same type as the preceding four built to the firm's own order. She will be of 8,800 deadweight tons, and will probably burn oil.

Tankers, Prince Rupert, Can.—W. P. Hinton, vice-president of the Grand Trunk Pacific Railway, announces that the Prince Rupert Drydock & Engineering Company has closed a contract for building five steel tankers. Newman C. Erb, of New York, controls this company.

Convert Freighters, Pensacola, Fla.—Five freighters, bought from the Shipping Board by the American Fuel Oil & Transportation Company, of 7,285 tons deadweight each, will be sent to the Pensacola Dry Dock & Shipbuilding Company to be converted into bulk oil carriers.

Tankers, San Pedro, Cal.—The Anglo-Saxon Petroleum Company, a subsidiary of the Royal Dutch Shell Oil Company, has placed a contract with the Southwestern Shipbuilding Company for the construction of three Isherwood framed tankers of 8,400 deadweight tons each.

To Convert Hulls, Portland, Ore.—The wooden hull Egeria, 3,500 deadweight tons, has been bought by H. W. Pennell and associates, of Portland, and will be converted into a steam schooner. The Acarmen, another of the hulls recently sold, is to be converted into a barkentine.

Ferryboat, New York.—Bids have been called for in the preliminary plans for the construction of a new ferryboat for use to Staten Island. Grover A. Whalen, Commissioner of Plant and Structures, will issue the call and the bids will be opened October 11. The estimated cost of the boat is $600,000.

Barges, Bath, Me.—The Kelly-Spear shipyard, which has been idle for several months, is to start up again, Manager Sawyer having obtained contracts to build two coal barges of 3,000 tons deadweight capacity each for the Staples Transportation Company, of Fall River, Mass., to be completed in ten months.

Combination Ships, Sparrow's Point, Md.—The Bethlehem Shipbuilding Corporation will build two 20,000-ton ore and oil carriers of a combination type for the purpose of doing away with empty voyages either to or from loading points. The vessels will be adapted to carrying oil to South America and return with ore.

Rebuilding Steamer, Brooklyn, N. Y.—The steamer Brazos, of the New York & Porto Rico Line, is to be rebuilt by the Robins Dry Dock & Repair Company. She will be converted into an oil burner, a new deck added and her accommodations improved. Theodore E. Ferris has made the plans, and the cost will be about $1,250,000.

Barges, St. Helens, Ore.—A contract for the construction of two large barges for Swift & Co. has been signed by Captain J. H. Roberts, Portland, Ore., business representative of the St. Helens Shipbuilding Company. Work on the two barges is to start at once. The two barges will be 130 feet long, 34 feet wide and 7 feet deep.

Car Floats, Elizabeth, N. J.—The Moore plant of the Bethlehem Shipbuilding Corporation, Ltd., has a contract to build two car floats for the Western Maryland Railroad Company. Each will carry 22 railroad cars, and will be 347 feet long, 43 feet 7 inches beam and 11 feet 6 inches molded depth amidships, and will be completely equipped.

Tankers, Vancouver, Wash.—The G. M. Standifer Construction Corporation has received a contract from the Imperial Oil Company of Canada for two 12,000-ton tankers. Each boat will require 2,700 tons of plates and 1,500 tons of shapes. Deliveries on this material will start in October. Eastern plate and structural mills have the inquiries for this tonnage.

Steamships, Rio de Janeiro, Brazil.—A new shipping company, the Companhia Nacional de Transportes Maritimos Uniao Luse Braziliera, proposes to place orders soon for twelve steamships of about 2,000 tons each. The company will establish a line between Portugal and the Portuguese colonies, New York, Central America, Hamburg and other European ports.

Reconditioning Sailing Ships, San Francisco, Cal.—Eleven big German ships which were interned at Santa Rosalia, Mexico, during the war, are to be towed to San Francisco, where they will be cleaned and repaired. The vessels are the Adolph Vinnen, Egon, Hans, Havestebude, Orotava, Reinbek, Schubek, Walkure, Wandsbele, Thielbek and Lasbele.

Life Rafts, Saginaw, Mich.—The American Safety Navigation Company, a $30,000,000 corporation, contemplates the erection of a plant costing about $15,000,000, to manufacture aluminum life rafts for use on seagoing vessels. Options have been obtained on 1,400 feet of river frontage, with a depth of 450 feet. R. W. Carnahan is vice-president and general manager.

To Alter Ships.—It is reported that the two 10,500-ton deadweight cargo carriers which the Merchant Shipbuilding Corporation is building at its Chester, Pa., yard for the Shawmut Steamship Company, of New York, are to be altered for third-class passenger service. A description of the original design of these vessels was published on page 714 of our September issue.

Steel Vessels, Oakland, Cal.—With the launching recently of the steamer Heber by the Union Construction Company that concern completed its original contract with the Emergency Fleet Corporation for ten steel cargo vessels, and is now able to accept contracts from private concerns. In addition to new contracts, the company has under construction eleven other private vessels.

To Repair Steamer, Quincy, Mass.—The Shipping Board steamer Trimountain, operated by McAllister Bros., 24 State street, New York, has gone to the Fore River yard of the Bethlehem Shipbuilding Company, where she will undergo repairs to her Scotch boilers, which were built at another plant. Three furnaces are being renewed and six others are being jacked back to their original shape.

Concrete Tankers, San Diego, Cal.—The Pacific Marine & Construction Company is building two reinforced concrete tankers of 7,500 tons deadweight capacity for the Emergency Fleet Corporation. One of these tankers, the Cuyamaca, has been chartered by the France & Canada Steamship Company, of New York, and the other, the San Pasqual, by the Columbus Shipping Company, of New York.

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Construction of Transport.—The Virginia Shipbuilding Corporation was the lowest bidder for the construction of the transport Heywood, at a price of $2,493,000. Other proposals were from the Bath Iron Works, Todd Dry Dock & Construction Corporation, Bethlehem Shipbuilding Corporation, Union Construction Company, Downey Shipbuilding Corporation, and William Cramp & Sons Ship & Engine Building Company.

Contracts Canceled, Sparrow's Point, Md.—The Bethlehem Shipbuilding Corporation has received notice from the Shipping Board of its intention to cancel contracts for construction of the last three 535-foot combination passenger and cargo liners, because of delay in deliveries. These vessels were estimated to cost about $6,000,000. They were to be of 13,000 deadweight tons, with engines capable of developing a speed of 18 knots.

Towboats, Seattle, Wash.—A. W. Carlson, who bought the Duwamish shipyard of the Inter-Ocean Barge & Transport Company, has built a towboat for Henry G. Seaborn's lumber schooner Camano, and has orders for several more for the same owner. In addition he will convert a former navy subchaser into a cruiser yacht for George Trahey, dockmaster at the Naval Station, Puget Sound, and has other contracts in sight.

Motorship, Tacoma, Wash.—A contract for a steel 6,500-ton motorship has been awarded to the Todd Dry Dock & Construction Corporation by the Alaska Steamship Company. The vessel will be 360 feet overall, 49 feet 6 inches molded beam, 26 feet 9 inches molded depth, draft, loaded, 22 feet. It will be propelled by two McIntosh & Seymour true Diesel engines of the four-cycle type, each having six cylinders and developing 1,200 indicated horsepower at 140 revolutions per minute.

Tankers, Wilmington, N. C.—The Syros, the eighth and last ship of the contract for 9,600 dead weight ton freighters, which the George A. Fuller Company, Wilmington, N. C., had with the Emergency Fleet Corporation, was successfully launched on September 18, making an average of a ship every seven weeks since the first launching about a year ago.; keels are laid and work well under way for the two 9,200 dead weight ton tankers which the George A. Fuller Company is building for a British oil company. These tankers are to be delivered in January and February, 1921, which will be a record for this yard.

To Build Battleship, Quincy, Mass.—The Fore River yard of the Bethlehem Shipbuilding Corporation, Ltd., is to build the world's largest, most powerful and fastest battleship for the United States Government. She will be called the Lexington, and will have a main battery of eight 6-inch guns, a full complement of smaller guns, and with electric propulsion developing 180,000 horsepower, is designed to have a speed of 35 knots, obtained partly through the use of armor plate exceptionally strong, but of only 5 inches thickness. She will be 874 feet long over all, with a beam of 101 feet and 43,200 tons displacement.

SHIPYARDS AND DRY DOCKS

New Repair Plant, Baltimore, Md.—The Sun Machinery & Iron Works, Stewart Building, was organized, with a capital of $25,000. Harold Johnson, president.

Shipyard Expansion, Quincy, Mass.—The Bethlehem Shipbuilding Corporation recently purchased two acres for its Fore River Works for expansion when required.

Plants Absorbed, Galveston, Tex.—The Gray's Engineering Works has acquired the plants and business of the Marine Iron Works and the International Iron Works.

Machine Shop, Norfolk, Va.—The Marine Iron Works Company, Inc., is having plans prepared for a two-story machine shop, 60 by 75 feet, to cost about $75,000. R. O. Colonna is president.

Dry Dock, Havre, France.—A floating repair dock capable of taking vessels of over 300 yards long, has been successfully launched. It is said to be the largest structure of its kind.

New Shipbuilding Plant, Germany.—Under the name of Die Neue Oderwerft, a new shipbuilding firm has ben established at Frauendorf, near Stettin, with the participation of Stettin insurance companies.

Shipyard Expansion, Elizabeth City, N. J.—The Elizabeth City Shipyard Company has added to its equipment an electric welding plant for use in connection with ship construction and repair and machinery repair work.

Shipyards Bought.—It is reported that A. C. Pessano has bought the plants of the Great Lakes Engineering Works at Ecorse and Detroit, Mich., and Ashtabula, Ohio, a stockholders' meeting having voted in favor of the sale.

Ship Repair Plant, Jacksonville, Fla.—It is reported that the Saliger Ship Salvaging Corporation, of New York, has secured a 300-foot water-front site to establish a dry dock, repair and salvaging plant. Frank Davenport is Southern representative.

Marine Railway and Dry Dock, Oakland, Cal.—Orders are being placed by the Hanlon Dry Dock & Shipbuilding Company for material to be used in building an additional marine railway. Plans and specifications for a floating dry dock are in preparation.

Shipyard Improvement, Quincy, Mass.—The Aberthaw Construction Company, 27 School street, Boston, has contract for building an addition to the power house at the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd.; about $75,000.

Shipyard to Reopen, Moss Point, Miss.—The Hodge Ship Company will reopen its plant in October, according to plans worked out for the construction of barges and medium-sized vessels there. The plant was created by the Emergency Fleet Corporation.

Shipyard Improvement, Oakland, Ca.—The Moore Shipbuilding Company has filed plans for a three-story reinforced concrete machine and construction shop to cost about $105,000. It has been awarded a contract for a 10,000-ton tanker for the Vacuum Oil Company.

Shipyard for Sale, New London, Conn.—The plant of the New London Marine Iron Works, recently used as a ship repair yard, has been placed on the market. The property is improved with a number of buildings, including machine shop, foundry, power plant, etc.

Shipyard for Sale, Mobile, Ala.—The Shipping Board has asked for bids on the shipyard formerly operated by Fred T. Ley & Company. The property has a pier 1,380 feet long by 40 feet wide and about three miles of railroad track. Bids will be opened in Washington, October 8.

Dry Dock, Vancouver, B. C.—The contract for the $3,000,000 dry dock on Burrard Inlet by J. Coughlan & Sons has been signed in Ottawa, and contains a provision that the work is to be started within sixty days of the completion of the deed. This means the construction of the dock should be commenced before the end of September.

New Ship Repair Company, New York.—The College Point Dry Docks & Supply Company has been incorporated, with a capital of $200,000, by G. F. Losche, E. B. Hallett and A. P Anderson, 34 Nassau street, to manufacture iron and steel castings for marine service and operate a ship repair plant.

New Plant, Brooklyn, N. Y.—Stephen Ransom, 401 West street, New York, operating a marine repair works, has filed notice of change of name to the Stephen Ransom Dry Dock & Repair Corporation. The company is building a new plant on Hamilton avenue to cost about $250,000, including equipment.

Drydock Nearing Completion, Portland, Oregon.—The first section of the new 15,000-ton drydock under construction for the Commission of Public Docks, was launched recently. The second pontoon is nearing completion and the third is now under construction. The drydock will be ready by January, 1921.

Shipyard Expansion, New Windsor, N. Y.—The proposed new building of the Newburgh Shipyards, Newburgh, N. Y., will be equipped for fabricating steel plates and shapes for ship construction. A large crane will be operated along the center of the east side of the building and two 80-foot cranes will be used through the center and west side.

Will Enlarge Plant, Elizabeth, N. J.—The Bethlehem Shipbuilding Corporation has arranged an improvement programme to cost about $1,000,000 at its Moore plant. A number of new buildings will be constructed and plans for the erection of the first of these, to cost $175,000, have been completed. The yard is now employing about 1,200 men, with weekly payroll aggregating approximately $40,000.

Dry Dock and Ship Repair Plant, Norfolk, Va., purchased a large tract of land adjoining the Norfolk & Western Railway piers, where a dry dock and ship repair plant calling for the expenditure of about $5,000,000 will be built. The dry dock will be of the floating type and will contain all the most modern improvements. Construction will be in charge of the Home Corporation, of which E. A. Miller is first vice-president.

New Yard Planned, Muskegon, Mich.—A site covering more than 100 acres on the north shore of Muskegon Lake has been secured by a group of Chicago and Milwaukee business men, who plan to construct shipbuilding yards which will cost around $1,000,000. This company, it is understood, will be a $3,000,000 company to start with. When the plant is equipped to handle ships two dry docks will be constructed.

Will Build Vessels, Savannah, Ga.—Eli Ness, who bought the South Side shipbuilding plant at Jacksonville, Fla., will improve the property and operate it for the building of ships. The plant was formerly owned by the Merrill-Stevens Shipbuilding Corporation, and was taken over by the Shipping Board. The sale was on the agreement that the new owner would operate the plant as a going concern for a period of five years or else pay the city $100,000 damages.

PORT IMPROVEMENTS

Dredging, Yarmouth, N. S.—The Department of Public Works, Ottawa, will soon receive bids for dredging the harbor here. About $49,880.

Wharf, New Orleans.—The Dock Board, Tiley McChesney, secretary, plans to extend and repair Pauline street wharf; Alexander & Juliani, contractors; $24,000 appropriated.

New Orleans Improvements.—The General Assembly of the State of Louisiana has approved an appropriation of $6,500,000 for improvement of the harbor and dock facilities.

Coal Docks, Savannah, Ga.—Savannah Coal Dock Company was chartered, with a capital of $600,000, by Samuel B. Howard, Raymond J. Gorman and Robert K. Thistle, all of New York.

Bulkhead, Sewell's Point, Va.—The Norfolk & Portsmouth Belt Line Railroad will build a bulkhead at Sewell's Point and also dredge in front of same. George D. Shafer, Nofolk, Va., is president.

Wharf, St. Francois D'Orleans, Que.—The Department of Public Works, Ottawa, Can., let contract for repairing the wharf to S. Rattee, St. Anne de Beaupre. About $33,000, cost plus percentage basis.

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Municipal Docks, Portsmouth, Va.—The City Council plans an appropriation of $3,500,000 for freight-handling machinery, conveying and loading machinery, cranes, etc., for the city's new municipal docks.

Pier, Los Angeles, Cal.—The Common Council retained Barnard & Leeds, consulting engineers, Central Building, to prepare plans for a new municipal pier of mole type at San Diego. Bonds voted for project.

Foundation Piers, Oswego, N. Y.—E. S. Walsh, Superintendent of Public Yorks, Albany, N. Y., will receive bids until October 13 for building concrete foundation piers for proposed grain elevator on Barge Canal terminal pier.

Pier, Manila.—The Pacific Mail Steamship Company will build a large private pier, permission having been obtained from the Philippine Government. The pier will be four times larger than any at Manila at the present time.

Harbor Improvement, Port Stanley, Ont.—Department of Public Works, Western Building, Ottawa, Canada, is having plans prepared by J. B. Hunter, engineer, for harbor improvements and new swing bridge at Port Stanley, Ont. About $350,000.

Dock, Minneapolis.—Minneapolis, St. Paul and Sault Ste. Marie Railroad, Soo Line Building, is having plans prepared for a 1,250-foot concrete and steel dock, 500 feet wide across face. About $1,000,000. E. A. Whitman, Minneapolis, chief engineer.

Terminal, San Francisco, Cal.—Plans for a multiple-story ocean and rail warehouse terminal at Channel street were approved by the Board of State Harbor Commissioners. The improvement will cost about $2,300,000, and work will commence within sixty days.

Canal, Port Talbot, Ont.—The Great Lakes and Atlantic Canal & Power Company, Ltd., care of N. M. Cantin, president, St. Joseph, Ont., is having surveys made for a 43-mile canal, 400 feet wide, 35 feet deep, from Port Frank to Port Talbot; about $50,000,000.

Locks, Bell Island, Ill.—F. I. Bennett, Director of Public Works and Buildings, Division Waterways, 25 East Jackson Building, Chicago, Ill., will receive bids until October 18, 1920, for building Marseilles Lock, near Bell Island, in Illinois River. M. G. Barnes, chief engineer.

Port Terminal, San Francisco, Cal.—Plans have just been approved by the California State Board of Harbor Commissioners for a $2,300,000 six-story ocean and rail warehouse terminal to be constructed. The largest ship may dock there and cargo may then be put in storage at the harbor front.

Piers, Bulkheads, Etc., Brooklyn, N. Y.—E. S. Walsh, superintendent of Public Works, Capitol, Albany, N. Y., will receive bids until October 13, 1920, for driving foundation piles for proposed grain elevator, building bulkhead wall along Henry street slip and dredging Henry street basin at Gowanus Bay.

Municipal Dock, Wilmington, N. C.—The City has purchased the Liberty Shipyard plant in that city for $37,500. The yard was used to build vessels for the Government during the war, and will be used as a municipal dock, the land covered by the yard having been mainly donated by the citizens of the town.

Channels Chillicothe, Mo.—Grand River D. D., Livingston and Linn Counties, are having plans prepared by the Morgan Engineering Company, Goodwyn Institute, Memphis, Tenn., for 30-mile cut-off channels from 10-100-feet base in the Grand River, also river improvements involving 4,000,000 cubic yards drag-line excavation. J. T. Millbanks, chairman.

Pier Reconstruction, New York City.—The Commissioners of the Sinking Fund have adopted a resolution recommending the issue of corporate stock in the sum of $315,000, for building a shed and reconstructing the pier at East 24th street, and dredging the slips to a depth of 25 feet. A lease of the pier was granted to Carroll, Hagan & Carroll for a term of ten years.

Wharf and Shed, Manchester, Texas.—A wharf and shed costing $300,000 is to be built on the Houston Ship Channel, on a site to be deeded to the city by the Manchester Corporation. The deed is for twenty acres of land with a 1,500-foot channel frontage, and sufficient land to extend the municipal belt line through the Manchester property. Money for the work is available.

Harbor Improvement, Korea.—The Harbor of Fusan, in Korea, is to be greatly improved. The present harbor facilities having been found inadequate to meet the growing trade, and a new plan is under consideration to build a breakwater 1,800 yards long and to extend the two existing piers by 800 yards, to reclaim 27,500 tsubo of land and to dredge 220,000 tsubo to a depth of 24 feet. It is estimated that the work will cost over 9,000,000 yen and take six years for completion.

Pier Equipment, Etc., Brooklyn, N. Y.—Cranes, hoisting, conveying and other machinery will be installed at the new piers and warehouses to be constructed by the American Chain of Warehouses, Cleveland, Ohio, A. H. Greeley, president, on Mill Basin, Jamaica Bay. A proposition has been tendered by the company to the New York Dock Department covering a leasehold of the site for fifty years. It is proposed to build six piers and four supporting warehouses, with a total cost estimated in excess of $525,000,000.

Harbor to be Developed, Koenigsberg, Germany.—Plans for the projected expansion of Koenigsberg harbor include the construction of a tugboat harbor with a depth of 3.5 meters (1 meter = 3.28 feet) at the upper end of the city; the dredging and straightening of the river Pregel at Cosse, for which undertaking 900,000 marks have already been voted, and the construction of five harbor basins on the left bank of the Pregel. The city's commerce was seriously hampered by the shallowness of the harbor and the lack of facilities in the harbor for handling even the smalest vessels.

Pier and Dock Construction, Equipment, Etc., Philadelphia, Pa.—George F. Sproule director Department of Wharves, Docks and Ferries, has sent a communication to the Mayor covering the proposed programme for pier and dock construction, estimated to cost $20,000,000, including cranes, hoisting, conveying and other necessary machinery. Immediate construction estimated at $11,000,000 is to include new piers, 110-112 South Wharves, each 300 feet wide by 1,200 feet long, to cost $4,000,000 each, with machinery installation. Other work will include the construction of similar structures at the Moyamensing Pier group.

To Build Docks, Vancouver, Wash.—The city of Vancouver proposes to have a municipal dock built on the public levee. The estimated cost of the dock is $130,000, including dredging, and $200,000 worth of structures are already on the levee, which can be utilized. The proposed dock will care for two ocean-going ships at the same time, in addition to smaller craft. Plans include both open and closed docks, the former being 465 feet long and the latter 500 feet; warehouses, 500 x 100 feet; facilities for handling 100,000 tons of cargo and 50 railroad cars at the same time. Storage capacity will be for two ocean ships. Small ocean and river steamers can be accommodated until the 30-foot channel is secured.

GOVERNMENT WORK

Dredging, Appomattox River, Va.—U. S. Engineer Office, Norfolk, Va., will receive bids up to noon, October 22, for dredging in Appomattox River, Va. Information on application.

Bulkhead, Etc., Tampa (Fla.) Harbor.—Work will be begun soon on a Government engineer depot at Seddon Island. A bulkhead will be built and coal bins and oil houses will be erected.

Mine Yawls.—Quartermaster General, Transportation Service, Munitions Building, Washington, D. C., will receive bids until 11 A. M., October 4, for construction of 24-foot motor mine yawls. Plans and information on request.

Dredging, Providence, R. I.—Sealed proposals will be received at the United States Engineer Office, until 1 P. M. (standard Eastern time), October 11, 1920, for dredging in Thames River, Conn. Further information on application.

Steel Barges, Nashville, Tenn.—Under bids opened September 13 by the United States Engineer Office the contract for furnishing four steel barges was awarded to the Chas. Ward Engineering Works, Charleston, W. Va., at $66,000.

Steel Barges, Memphis, Tenn.—Sealed proposals will be received at the office of the Mississippi River Commission, First and Second Districts, Custom House, until 11 A. M., October 11, 1920, for furnishing five steel barges. Further information on application.

Tracks for Drydock, South Boston, Mass.—Specification 4196, the Bureau of Yards and Docks, Navy Department, Washington, D. C., let contract for completing railroad tracks for the U. S. Naval drydock at South Boston, Mass., to M. Seretto, 3 Tremont Row, Boston; $134,750 (120 days).

Iron Sinkers, Tompkinsville, N. Y.—The Superintendent of Lighthouses will open sealed proposals at 3 P. M., October 4, 1920, for 103 cast iron sinkers, each with forged mooring shackles, sinkers to vary from 1,850 to 6,500 pounds each, total approximate 220 tons. Further information on application.

Seaplane Runway, Hampton Roads, Va.—Specification 4267, the Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for building seaplane runway at Naval Operating Base, to have wood piles, concrete walls, piers and platform; $10 deposit required for plans and specifications.

Foundation for Turrets and Crane Tracks, Philadelphia, Pa.—Specification 4299, the Bureau of Yards and Docks, Navy Department, Washington, D. C., will soon receive bids for building concrete foundations for turrets and crane track at the Philadelphia Navy Yard; $10 deposit required for plans and specifications. Further information on application.

Steel Buoys, Tompkinsville, N. Y.—Sealed proposals will be opened by the Superintendent of Lighthouses, Tompkinsville, N. Y., at 3 P. M., October 14, 1920, for 83 steel buoys of various types and sizes, some with bells and whistles, some with superimposed skeleton steel towers, and the majority with bottom counterweight iron castings. Information on application.

Steel Dump Scows.—United States Engineer Office, Philadelphia, will receive bids until October 14 for the building and delivery of two, three or four seven-pocket steel dump scows of the bottom-dump type, each of about 850 cubic yards capacity. The number to be furnished will depend on the price bid; funds are available for the purchase of two, and as many more will be purchased as the price will permit. Full particulars on application; blueprints, $1.

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SHIPPING DEVELOPMENTS

Boston-Oriental Service.—The Barber Steamship Lines may establish a freight service from Boston to ports of the Far East.

New Steamship Line, Gulfport, Miss.—The Gulfport Fruit & Steamship Company has been incorporated, with a capital of $100,000, by Joseph Van Cooster, J. H. Lauf and John C. Simpson.

Steamship Company Formed, New York.—The Julius Kessler Steamship Company has been incorporated privately for the purpose of promoting trade with Canada, the United States and the West Indies.

Service to Greece, New York.—There is talk of establishing passenger service between New York and Piraeus and Constantinople, due to a realization of opportunities in the Greek and Turkish fields.

Steerage Service, New York.—The Hamburg-American Line announces that in January, 1921, it will resume its regular steerage service to New York with an 8,800-ton steamer, with other steamers following in February and March.

Steamer Sold, Mentor, Ohio.—The steamer H. H. Potter, the last of the four 600-footers built by the American Ship Building Company on its own acount to be sold, has been taken over by the Brier Hill Steamship Company, of Mentor, Ohio, recently organized.

For Business With Germany.—Plans are being made for the incorporation of the Buckeye Steamship Company to carry on a package business with Germany and Central European countries with wooden steamers. Ohio men are said to be concerned in the enterprise.

New Service to Cuba, New York.—The Oconee Steamship Company was recently incorporated to operate from New York to Guantanamo, Manzanilla, Santiago and Cienfuegos, the first steamer being the Oconee. The general manager is C. K. West, 9 Hanover street, New York.

Hamburg-New York Service.—The Luckenbach Steamship Company will inaugurate a cargo service from New York to Hamburg, with the sailing on October 6 of the first of the two fast freighters assigned for this operation. Other steamers will be placed on this service if tonnage warrants it.

New Line to Cuba, Pensacola.—A new steamship line between Pensacola and Mantanzas, Cuba, will be established by the Gulf, Florida & Alabama Railroad, according to H. W. Stigler, agent for the line in Memphis. The first ship will sail from Pensacola soon, and freight will be accepted for all points in Cuba, including Havana.

Steamship Company, Beaumont, Texas.—A new steamship company has been organized, with a capital of $300,000, it is announced by William Saenger, of Beaumont. Plans include the construction of two 4,000-ton steel ships to ply between Beaumont, Orange, Port Neches and Port Arthur, and Porto Rico, Vera Cruz, and Tampico.

American-Scandinavian Service, Philadelphia.—Plans for a joint port service between Philadelphia and Boston and Scandinavian ports, with regular sailings, have been completed by Charles T. Megee & Company, of Philadelphia, and C. H. Sprague & Son, of Boston. They will start operation with six freighters, and it is expected sailings will take place every three weeks.

Boston-U. K. Line.—The North Atlantic & Western Steamship Company, Inc., F. E. Gignoux, of Portland, Me., president, announces the establishment of a freight service between Boston, Portland, Liverpool and Glasgow. The company operates under the name of the Nawsco Line, the same name being given to the service the company plans between Boston and Pacific ports.

Barges and Tugs, New Bern, N. C.—Plans for purchasing six barges and two tugs for the proposed barge line between New Bern, N. C., and Baltimore, Md., stopping at Elizabeth, Washington and Norfolk, are in charge of W. F. Aberly, Wade Meadows and Harry Barlow, of New Bern, and Charles Flynn and Captain Lynch, of Washington. It is expected to have this line operating within a few weeks.

The Isthmian Steamship Line, operating ships built by the Chickasaw Shipbuilding & Car Company, Mobile, Ala., from Mobile to Rotterdam, has just established a port engineer's office at Mobile, which will be in charge of all repairs in the engine rooms and the buying of supplies for repairs, and will report to the head offices of the line in New York. R. V. & J. S. Taylor are agents for the line at Mobile.

Salvage Steamer Planned, San Francisco.—The recent stranding of the Dutch steamer Arakan near San Francisco has resulted in the shipping men of that city deciding that they must have an up-to-the-minute salvage steamer, with full equipment, ready for service at all times. According to those interested, the cost of the upkeep of such a vessel could be met in part by assessments on shippers and marine underwriters.

Sale of Kerr Ships, New York.—H. F. Kerr and Alfred E. Clegg, president and vice-president of the Kerr Steamship Company, have disposed of their interests in the fleet of ex-Austrian and ex-German cargo carriers which they controlled to the Harriman interests, and the ships will be turned over to the United American Lines. They also intend to dispose of large amounts of stock of the American Ship & Commerce Corporation to the same interests. The sum paid for the ships is said to be $5,000,000 in cash, which works out at a valuation of about $150 a deadweight ton.

Joint Terminal, Seattle, Wash.—A deal making the Skinner & Eddy yard, one of the largest ocean shipping centers on the Pacific Coast, was closed recently. The property totaling twenty-five acres will become the Puget Sound terminal of the Intercoastal, and a great trade fleet of the Isthmian Steamship Line, also the fleet of the Societe Generale des Transport a Vapeur of Marseilles, France. Twenty-five American steamships and three French ships aggregating a deadweight tonnage of 271,27., will ply to and from the terminal to ports of the Atlantic, Great Britain, France and North Africa.

Steamship Merger, Los Angeles, Cal.—Consolidation of the Los Angeles Steamship Company with the Los Angeles Pacific Navigation Company was announced by the officials of the Los Angeles-Pacific. Fred L. Baker, president of the Los Angeles Steamship Company, displaces L. D. Dale as president of the parent company. A. J. Frey will be general manager of combined operations. To this service will be added the steamers Yale and Harvard, now being overhauled. Acquirement of additional terminal facilities and enlargement of its fleet both by purchase and allocation from the Shipping Board are among the plans in early prospect of consummation.

South American Service, Philadelphia, Pa.—A recently organized firm for the development of direct service between Philadelphia and Ecuador is Chapman & Fisher, 524 Walnut street. Captain John H. Fisher, who has had long experience in marine transportation in Southern trades, is one of the senior members of the firm, and has taken Mr. Chapman, formerly with the Cramp shipyards and the Eastern Steamship Corporation, with him. The firm proposes to develop a business proposition between this country and Ecuador, of which two vessels, now under construction, are to be for a subsidiary organization. The firm is also associated with the Anchor Shipbuilding Company, of Washburn, Wis., constructing any type of vessel for lake or ocean service. Robert Kerr is vice-president and manager of the Anchor concern.

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